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ORDERING INFORMATION

Contact your Bird Products Corporation Dealer or Bird Products Corporation **Customer Service Department** directly:

1100 Bird Center Drive
Palm Springs, CA 92262
(800) 328-4139
(619) 778-7200
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TECHNICAL INFORMATION

Contact Bird Products Corporation **Technical Services Department** directly:

1100 Bird Center Drive
Palm Springs, CA 92262
(619) 778-7200 or
BIRD HELPLINE
(800) 934-BIRD
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AVIAN TRANSPORT VENTILATOR

SECTION 1.0: PRODUCT INFORMATION

1.1 WARRANTY

The products of Bird Products Corporation (Herein Bird) are warranted to be free from defects in material and workmanship and to meet the published specifications for one (1) year.

The liability of Bird under this warranty is limited to replacing, repairing or issuing credit, at the discretion of Bird, for the parts that become defective or fail to meet published specifications during the warranty period; Bird will not be liable under this warranty unless (A) Bird is promptly notified in writing by Buyer upon discovery of defects or failure to meet specifications; (B) the defective unit or part is returned to Bird, transportation charges prepaid by Buyer; (C) the defective unit or part is received by Bird for adjustment no later than four weeks following the last day of the warranty period; and (D) Bird's examination of such unit or part shall disclose, to its satisfaction, that such defects or failures have not been caused by misuse, neglect, improper installation, unauthorized repair, alteration or accident.

Any authorization of Bird for repair or alteration by the Buyer must be in writing to prevent voiding warranty.

Bird warranties as herein above set forth shall not be enlarged, diminished or affected by, and no obligation or liability shall arise or grow out of the rendering of technical advice or service by Bird or its agents in connection with Buyer's order of the products furnished hereunder.

- **LIMITATIONS OF LIABILITIES**

In no event shall Bird be liable to Buyer for loss of profits, loss of use, consequential damage or damages of any kind based upon a claim for breach of warranty, other than the purchase price of any defective product covered hereunder.

This warranty does not cover normal maintenance such as cleaning, adjustment or lubrication and updating of equipment or parts. This warranty shall be void and shall not apply if the equipment is used with accessories or parts not manufactured by Bird or authorized for use in writing by Bird, or if the equipment is not maintained in accordance with a prescribed schedule of maintenance.

The warranty stated above shall extend for a period of one year from date of delivery, with the following exceptions:

1. Electrical components for remote monitoring of physical variables such as temperature, pressure, oxygen saturation or flow are warranted for ninety (90) days from date of receipt.

2. Elastomeric components and other parts or components subject to deterioration over which Bird has no control are warranted for sixty (60) days from date of receipt.

The foregoing is in lieu of any other warranty, expressed or implied, including, without limitation, any warranty of merchantability, except as to title, and can be amended only in writing by a duly authorized representative of Bird.

SECTION 1.0: PRODUCT INFORMATION

1.2 INTRODUCTION

The Avian Transport Ventilator is a time or volume cycled ventilator, which can support a variety of ventilation modes. The modes are Control, Assist/Control, SIMV and CPAP. The ventilator's compact, simple design is easy to use and extremely durable.

The Avian Transport Ventilator is microprocessor controlled. The ventilator provides the operator with a variety of controls and comprehensive alarms that include the following items:

- Volume and time cycled ventilation
- Automatic apnea backup ventilation
- Proximal airway pressure monitoring
- 5-100 LPM peak flow
- 0-20 cm H_20 PEEP (with removable PEEP valve)
- Breath rate from 0-150 BPM
- Audio/visual alarms for high/low peak pressures, apnea, inverse I:E ratio and patient circuit disconnect.

1.3 INTENDED USE

The Avian Transport Ventilator is suitable for pediatric and adult patients in clinical, field hospital, aeromedical, and transport settings. Its compact, durable exterior and lightweight design make the Avian exceptionally easy to transport and store.

This ventilator is a self-powered unit using its own internal, rechargeable battery; additionally, each Avian Transport Ventilator is packaged with a 115/230 VAC switch selectable AC power supply and a 12 VDC power cable to allow for connection to external 11-30 VDC power sources.

The Avian Transport Ventilator operates from gas sources capable of delivering between 40-60 PSIG, including compressed gas cylinders (air, oxygen or air/oxygen mixtures), medical grade air compressors or on-board aircraft gas sources. The gas input of the ventilator can also accept blended gas mixtures from a gas blender.

1.4 PRODUCT SPECIFICATIONS

1.4.1 Electrical

ELECTRICAL	VOLTAGE/HZ
External DC Power	External Input Voltage 11 to 30 VDC (Positive or Negative Polarity)
Internal Battery	6 Volt Rechargeable Sealed Lead Acid (11 Hours min. operation on full charge)
External Power Adapter (Switch selectable input)	100 - 125 VAC, 50 - 400 HZ 220 - 250 VAC, 50 - 400 HZ

1.4.2 Alarms

ALARMS	DESCRIPTION/LIMITS
High Peak Pressure	1 to 100 cmH_2O
Low Peak Pressure	OFF, 2 to 50 cmH_2O
I:E Ratio (inverse)	Audio/Visual
Apnea	Audio/Visual (automatic - 20 sec.)
External Power - Low & Fail	Audio/Visual
Disconnect	Audio/Visual
PEEP Not Set	Audio/Visual
Battery Low/Fail	Audio/Visual
Alarm Silence/Reset	Variable Duration *(depending on the alarm)* Single Touch Button

1.4.3 Controls

CONTROLS	DESCRIPTION
Modes	OFF, Control, Assist-Control, SIMV, CPAP and CAL
Breath Rate	0 to 150 bpm
Flow	5 to 100 lpm
Inspiratory Time	0.1 to 3.0 seconds
Tidal Volume	50 to 2000 ml
Assist Sensitivity	-2 to -8 cmH_2O
Manual Breath	Touch button activated
PEEP/CPAP	0 to 20 cmH_2O (with removable PEEP valve)
Sigh	On/Off 1 sigh/100 breaths or 7 minutes; 1.5 X Inspiratory Time (3.0 sec. max.) or Tidal Volume (2,000 ml max.) setting; 1.5 X High Pressure setting (100 cmH_2O max)
Manual (PEEP) Reference	Set 0 to 20 cmH_2O
Pressure Relief	10 to 100 cmH_2O

1.4.4 Monitors/Indicators

MONITORS/INDICATORS	DESCRIPTION
Green LED	Power On
Yellow LED	External Power
Red LED	Peep Not Set Apnea Battery (Low/Fail) External Power Failure Vent Inoperative Disconnect
4 Digit 7 Segment LED	Display (M.A.P.) Mean Airway Pressure 0 to 100 cmH_2O (P.I.P.) Peak Inspiratory Pressure 0 to 100 cmH_2O (Paw) Airway Pressure 0 to 100 cmH_2O Low Peak Pressure, Off, 2 to 50 cmH_2O High Peak Pressure 1 to 100 cmH_2O Inspiratory Time 0.1 to 3.0 seconds Tidal Volume 50 to 2000 ml Breath Rate 0 to 150 bpm Flow 5 to 100 LPM
LED Bar Graph	Airway Pressure -10 to 100 cmH_2O

1.4.5 Pneumatic

PNEUMATIC	INPUT SOURCE
40 to 60 psig of clean, dry medical grade air, oxygen or air-oxygen mixtures. 100 lpm minimum flow.	Compressed gas cylinders Medical grade air compressors On-board aircraft gas sources Blended gas mixtures from a gas blender

NOTE: Internal Bleed 2 - 3 LPM.

1.4.6 Physical Characteristics

PHYSICAL CHARACTERISTICS	DIMENSIONS - RANGES
Height	10 Inches (254 mm)
Width	12 Inches (305 mm)
Depth	5 Inches (127 mm)
Weight	10 Pounds (4.5 Kkg)
Operating Temperatures	-4°F to 115°F (-20°C to 46°C)
Storage Temperatures	50°F to 80°F (10°C to 27°C)

1.5 ORDERING INFORMATION

1.5.1 System Components

PART NUMBER	DESCRIPTION
15345	**Avian Transport Ventilator system includes the following:**
15365	Avian Transport Ventilator
10290	Carrying Case
15364	DC Input Cord
68107	Power Supply
09184	Power Cord
10293	Hose Assembly, O2
10333	Patient Circuit Kit
L1248	Instruction/Service Manual

1.5.2 Circuit Components

PART NUMBER	DESCRIPTION
10333	**Patient Circuit Kit includes the following:**
20516	Tubing, Smooth Bor
33687	Peep Valve
33686	Exhalation Valve
10294	Tube Assembly, Airway Pressure (3/16" I.D.)
10295	Tube Assembly, Exh. Valve Drive (1/8" I.D.)

1.5.3 Accessories

PART NUMBER	DESCRIPTION
10317	Blender Mounting Kit
15414	Exhalation Valve Diaphragm Replacement Kit
15440	Blender-Ventilator O_2 Hose

1.5.4 Recommended Spare Parts List

PART NUMBER	DESCRIPTION
00358D	Connector, 1/8" Tube Tee
01741D	Tube Connector, 4.5mm X 1/8" (exhalation drive)
01943	O-ring, Inlet Filter Assembly
02040D	Tube Connector, 5.0mm X 1/8" (for 1/8" I.D. proximal pressure tubing)
03286	Spring, 110 IDX.2X.3
03826	Screw, 10-32 X 2.24 Hex Cap
04029X	Tube, 1/8" ID Silicon (solenoid valve bleed)
04381	Screw, 6-32 x .250
05307D	O-Ring, .239 X .070
05327D	O-Ring, .739 X .070
06804	Filter Element, Nylon Cone
08434	Screw, 6-32 X .50
09510	Fuse, 1 Amp/250V, Timelag
15292	Cable Assembly, Power Supply
15293	Cable Assembly, Battery
15484	Pneumatic Manifold Assembly
20227	Connector, Diss O2, 1/4"
20238	Control Knobs
20496	Case, Base (bottom)
20497	Case, Lid (top)
20969	Manifold Panel
20518	Plate, Latch
20519	Latch
20523	Cover, Battery
20529	Muffler, Bleed
20866D	Tube Connector, 5.0mm X 3/16" (for 3/16" I.D. proximal pressure tubing), fits Bird reusable circuit
33685	Gasket, EMI/O-Strip
33688	Bump, .50 diameter
40082	Screw, 10-32 X .375
40084	Screw, 6-32 X 2.0
40085	Screw, 6-32 X .25
40088	Screw, 6-32 X 1.312
50370A	PCB, Main
50380A	PCB, Display
50390A	PCB, Power Supply
68106	Battery, 6V
80113	Label, Instruction
80136	Front Panel Overlay
80125	Switch Panel

AVIAN TRANSPORT VENTILATOR

SECTION 2.0: WARNINGS, CAUTIONS AND NOTES

2.1 INTRODUCTION

Before using or servicing the Avian Transport Ventilator, the user should read and understand all warnings and cautions in this manual. When appropriate, warnings and cautions will be repeated at the start of a section or will precede an instructional paragraph. Notes are not included in this section and will immediately precede instructional paragraphs.

2.2 DEFINITIONS

WARNINGS!

These messages advise the operator of conditions that could have an adverse effect on the patient or the operator. These messages will be identified by the warning indicator that is directly to the left.

CAUTIONS ✓

Caution messages are used to identify conditions that could damage the Avian Transport Ventilator or other equipment. These messages will be identified by the caution indicator that is directly to the left.

NOTES:

Notes are used to draw attention to specific items that will help the operator or technician to better understand the Avian Transport Ventilator. These messages will precede an instructional paragraph. These messages are identified by the note indicator that is directly to the left.

2.3 WARNINGS

WARNINGS!

- If the Avian Transport Ventilator fails the Performance Check, **do not** attempt to operate the ventilator until the performance specifications have been restored and verified.
- Technical repairs should be accomplished by qualified personnel, trained either by Bird Products Corporation or its authorized trainers. BIRD PRODUCTS CORPORATION IS NOT RESPONSIBLE FOR UNAUTHORIZED REPAIRS OR REPAIRS MADE BY UNAUTHORIZED PERSONNEL.

SECTION 2.0: WARNINGS, CAUTIONS AND NOTES

WARNINGS!

- The Avian Transport Ventilator must pass a full technical performance check following any repair.
- Always replace the fuse in the power supply with a fuse of the same voltage and current rating. Failure to do so could result in injury to personnel or severe damage to the Avian Transport Ventilator.
- Always operate the ventilator with clean, dry medical grade gas. Failure to do so can result in contamination of the unit. The contamination of the unit could jeopardize the patient by causing improper operation and/or premature failure of the ventilator.
- The operation of the ventilator audible and visual alarms should be verified daily.
- The Avian Transport Ventilator is a restricted medical device. It is intended to be operated by qualified medical personnel under the direction of a physician.
- When the ventilator is connected to a patient, it is recommended that a trained clinician be in attendance at all times to take prompt action should an alarm or other indication of a problem occur.
- It is the responsibility of the clinician or user to establish and set the controls and monitor the alarm settings for each patient and mode of operation.
- Consult a qualified physician when using an air/oxygen blender for proper fractional inspired oxygen (FIO2) concentrations.
- Monitor patient oxygen concentrations at or near the proximal airway. Use a calibrated oxygen analyzer to verify the oxygen concentrations.
- Do not use the ventilator in the presence of flammable anesthetics as an explosion hazard exists.
- The compressed gas source must be between 40 and 60 PSI and be able to deliver a minimum of 100 LPM flow.

WARNINGS!

- If an external auxillary filter is unavailable or cannot be used, the Avian Transport Ventilator inlet filter must be frequently checked for build-up of debris. Filter elements contaminated with moderate amounts of debris should be immediately replaced to avoid the possibility of a ventilator malfunction.

- The Low Peak Pressure Alarm should always be set to an appropriate level to alert the operator in the event of a pressure loss.

2.4 CAUTIONS

CAUTIONS ✔

✔ Do not sterilize the Avian Transport Ventilator. The internal components are not compatible with sterilization methods.

✔ External cleaning and sterilization of the Avian Transport Ventilator with agents that include phenols, ammonia chloride, chloride compounds and/or those with a greater than 2% concentration of glutaraldehyde are not recommended. These agents may cause damage to plastic components and/or control panel overlays.

✔ Prolonged storage at high temperatures (above 80°F/27°C) can result in premature battery failure. Failure to recharge the battery while it is in storage will also cause premature failure of the battery.

✔ Before disassembling the Avian Transport Ventilator:

- Place the ventilator Mode Switch in the OFF position
- Disconnect the external power supply from the unit
- Remove the battery from the ventilator

✔ Always follow proper static grounding procedures when removing and replacing the ventilator's printed circuit boards.

✔ The calibration accuracy of all test equipment used to test and calibrate the Avian Transport Ventilator should be verified before recalibrating the ventilator.

SECTION 2.0: WARNINGS, CAUTIONS AND NOTES

CAUTIONS ✔

- ✔ The correct polarity must be observed when the battery is replaced. The RED connector on the battery cable connects to the [+] battery terminal. The BLACK connector on the battery cable connects to the [-] battery terminal.
- ✔ Do not remove the entire inlet filter assembly from the ventilator when replacing the filter element and O-ring. If the entire inlet filter assembly must be removed, use extreme care to prevent debris from entering the manifold.
- ✔ Use caution when installing the new EPROM. Pay close attention to pin alignment and pin one (1) location. Be careful not to bend the IC pins when inserting the EPROM or PROM.
- ✔ To reduce the risk of electric shock, do not remove the battery cover. Refer servicing to qualified service personnel.
- ✔ An in-line nebulizer should not be used with the Avian Transport Ventilator when operating in the time cycled mode.
- ✔ The flow control valve of the Avian Transport Ventilator provides a constant mass flow for each breath, whether at ground level or in an aircraft. The lower ambient pressure at altitudes above ground level will cause the air to assume a larger volume. In other words, the actual volume delivered by the ventilator at altitudes above ground level will be greater than the tidal volume displayed on the unit. The actual volume delivered by the Avian Transport Ventilator can be calculated from the displayed tidal volume and pressure altitudes as shown in the Volume vs. Pressure Altitude Chart, Figure 4.1 on page 4-17.

AVIAN TRANSPORT VENTILATOR

SECTION 3.0: DESCRIPTION OF CONTROLS, ALARMS AND DISPLAYS

3.1 INTRODUCTION

This section describes the operation of the display, controls, and alarms. The explanations refer to the Front Panel Illustration, Figure 3.1 on page 3-14 and to the Pneumatic and External Power Panel Illustration, Figure 3.2 on page 3-16.

3.2 CONTROLS

3.2.1 Mode Control

The Mode Control selects the desired mode of operation. Item #12 on Figure 3.1, Front Panel Illustration, designates the location of the control. There are five (5) position settings, which are described in the following chart.

SETTING	FUNCTION
OFF	This setting turns the ventilator "OFF." The Vent Inoperative alarm will sound when the Mode switch is placed in the OFF position. The alarm can be silenced by pressing the Alarm Silence/Reset button. The ventilator inoperative visual alarm will continue to flash for approximately 30 minutes. The internal battery will continue to charge if the External AC Power source is connected to AC power and to the Avian Transport Ventilator.
CONTROL	All parameters of the delivered breath are controlled by the ventilator.
Assist/Control	This mode allows for the delivery of either a Control or an Assist/Control breath. The patient has the ability to augment the breath rate, but not the flow or tidal volume/inspiratory time. The patient may initiate an Assist/Control breath if both the following conditions exist: • The ventilator is not currently in inspiration or the minimum exhalation phase, and; • The patient inspiratory effort exceeds the Sensitivity trigger setting.

SETTING	FUNCTION
SIMV	In the SIMV mode, all control parameters are used with PEEP and Sigh as optional controls. Breaths can be totally patient controlled, or totally machine controlled with varying degrees of ventilator support between spontaneous breaths. The amount of patient or ventilator control is determined by the ventilator control settings.
CPAP	In the CPAP mode, the patient is allowed to breath spontaneously over an elevated baseline pressure. Tidal Volume or Inspiratory Time and Flow should be adjusted to appropriate levels for adequate minute ventilation should the patient become apneic and the ventilator reverts to Apnea Back-Up ventilation.
CAL	CAL mode provides a means for calibrating the airway pressure transducer to correctly read "zero" at ambient pressure. This mode allows the device to compensate for thermal and long term zero drift. Upon entering CAL mode a display test will activate, illuminating specific LED's and allowing the user to verify the operation of membrane switches and associated LED's. A detailed description of the display test is provided in Section 4, Operating Instructions.

3.2.2. Inspiratory Time/Tidal Volume

NOTE: Volume Cycled ventilation is the default form of ventilation. If the ventilator has been turned off, it will always revert to Volume Cycled ventilation when turned on.

This control is designated item #19 on Figure 3.1, Front Panel Illustration. This is a multiplexed control that allows for direct setting of Tidal Volume for volume cycled ventilation or Inspiratory Time for time cycled ventilation. Selection of **Volume** cycled ventilation or **Time** cycled ventilation is made by depressing the **Tidal Vol.**, or **Insp. Time** button.

Once a selection is made (Tidal Vol. or Insp. Time), a transition phase will be initiated, and the setting for the new selection will flash in the monitor window. During this transition phase, the ventilator will continue to ventilate the patient based on the former type of ventilation and at the former setting. The operator can adjust the new setting to the desired level.

The new selection must be activated by performing one of the following two actions:

A) Pressing the Display button for that control (Insp. Time or Tidal Volume) a second time.

In this case, the value displayed in the monitor window will cease flashing and will be displayed continuously.

or

B) Adjusting the new setting (Insp. Time or Tidal Volume), then adjusting the knob or pressing the Display button for another parameter on the ventilator. (High Pressure Limit, Low Peak Pressure, Breath Rate, Flow, Manual PEEP Ref., MAP, PIP or Paw)

In this case, the value for the selected parameter will be displayed in the monitor window.

Inspiratory Time	0.1 to 3.0 Seconds
Tidal Volume	50 - 2,000 ml

NOTE: To activate the new form of ventilation under Section 3.2.2.B, an adjustment must be made to the new setting **(Insp. Time or Tidal Volume)** before adjusting the knob or pressing the display button for the listed parameters.

CAUTION ✔

✔ In order to activate the newly selected form of ventilation, the operator must perform one of the actions outlined in Section 3.2.2. A or B. Failure to do so will result in the ventilator continuing to operate under the previous form and previous settings of the ventilator.

Should the operator wish to revert to the original form of ventilation during the transition phase (flashing value in the monitor window), this can be done by depressing the display button for the original form of ventilation.

3.2.3 Breath Rate Control

This control, designated as item #18 on Figure 3.1, Front Panel Illustration, is used to set the minimum number of ventilator mandated breaths per minute that can be delivered to the patient in the Control, Assist/Control and SIMV modes of ventilation.

Breath Rate	0 to 150 BPM

3.2.4 Flow

This control is designated as Item #22 on Figure 3.1, Front Panel Illustration. It is used to set the maximum flow delivered to the patient during a Control, Assist Control or mandatory SIMV breath that is delivered by the ventilator.

Flow	5 to 100 LPM

3.2.5 Assist Sensitivity

Item #16, on Figure 3.1, Front Panel Illustration, identifies the Assist Sensitivity control. The control is used to set the trigger level below baseline pressure for initiation of Spontaneous (CPAP), SIMV and Assisted breaths. This function is active in Assist/Control, SIMV and CPAP modes.

Assist Sensitivity	-2 to -8 cmH_2O

NOTE: The Avian Transport Ventilator is automatically PEEP compensated; therefore, the Assist Sensitivity will automatically adjust to follow the baseline pressure.

3.2.6 Manual PEEP Reference

The Manual PEEP Reference is located on the front panel and is designated as item #15 on Figure 3.1, Front Panel Illustration. To activate this function, depress and hold the button for three (3) seconds until the "A" disappears. Continue to hold this button to scroll from 0 to 20. When activated, this control allows the user to manually set the PEEP reference level. To deactivate this function, scroll past "20" until the "A O" reappears and release the button. This function is explained in detail in Section 4.0: Operating Instructions.

Manual PEEP Reference	0 to 20 cmH_2O

3.2.7 Pressure Relief

This control is designated as item #24 on Figure 3.1, Front Panel Illustration. It is used to set the maximum allowable pressure in the patient circuit during a mechanical breath. The desired level is set by adjusting the control while observing the Peak Inspiratory Pressure. It is explained in detail in Section 4.0: Operating Instructions.

Pressure Relief	10 to 100 cmH_2O

3.2.8 Sigh ON/OFF

The Sigh switch is identified as item #13 on Figure 3.1, Front Panel Illustration. It is used to turn the automatic sigh function ON or OFF. The Sigh breath, once activated, is delivered once in every 100 breaths or every 7 minutes, whichever occurs first, regardless of breath, (including Manual breaths), type. The Sigh breath is a Control breath equal to 1.5 times the current Inspiratory Time setting (limited to a 3 second maximum), or 1.5 times the current Tidal Volume setting (limited to a 2000 ml maximum) and delivered according to the current Flow setting. The high pressure limit is automatically increased by 1.5 times, not to exceed maximum available settings.

3.2.9 Manual Breath

This control is designated as item #14 on Figure 3.1, Front Panel Illustration. It is used to deliver a single operator initiated Control breath in accordance with the current Flow and Inspiratory Time or Tidal Volume settings. A Manual Breath initiated during the inspiratory or minimum expiratory phase of all breath types is ignored. Additionally, once a Manual Breath is initiated, the Breath Rate timer is reset, ensuring a full exhalation period before the next breath is initiated.

3.2.10 Display Controls

Several "push to display" controls are located on the front panel. When depressed, the Display buttons display the selected parameter on the 4-digit, 7-segment, LED display (item #8 on Figure 3.1, Front Panel Illustration). The controls with the "push to display" functions are the Breath Rate, Inspiratory Time/Tidal Volume, Flow, and Manual PEEP Reference. The alarm functions which include this feature are the High Pressure Alarm and Low Peak Pressure Alarm.

3.3 ALARMS

3.3.1 High Peak Pressure

NOTE: The High Peak Pressure alarm cannot be set below PEEP +1 cmH_2O.

The control for this alarm is designated by item #10 on Figure 3.1, Front Panel Illustration. This alarm establishes the maximum allowable pressure for all breath types. An alarm violation will occur when airway pressure exceeds the alarm setting. Once violated, the following events take place immediately:

- The audible alarm will sound and the visual indicator is illuminated.
- The ventilator will revert to an exhalation state, where flow is zero and the exhalation valve is opened.

- If patient pressure resets below 26 cmH_2O, normal ventilation will resume. If airway pressure remains above 26 cmH_2O, ventilation will remain suspended with continuous audible and visual alarms. The patient may breath spontaneously through the anti-suffocation valve at any time. The value of the alarm setting will be automatically increased by 1.5 times upon delivery of a Sigh breath. The increased value cannot exceed the 100 cmH_2O limit.

Range	1 to 100 cmH_2O
Silence	Yes
Silence Interval	30 seconds

3.3.2 Low Peak Pressure

NOTE: This alarm is active for Control and Assist/Control and mandatory SIMV breaths only.

The control for the Low Peak Pressure Alarm is designated as item #7 on Figure 3.1, Front Panel Illustration. The Low Peak Pressure Alarm is activated when airway pressure fails to exceed the alarm setting during the inspiratory phase of a breath. The alarm initiates audible and visual alarm indications.

Range	OFF (Flashing) 2 to 50 cmH_2O
Silence	Yes
Silence Interval	30 seconds

3.3.3 Alarm Silence/Reset

The Silence/Reset button is located on the front panel, as designated by item #3, Figure 3.1, Front Panel Illustration. This control allows the operator to temporarily disable some audible alarm signals and/or reset any flashing visual alarm indicators. If activated during an alarm condition, the audible portion of the alarm will be silenced and the Silence LED will illuminate throughout the silence interval. The silence interval will be a function of the specific alarm being silenced. Depressing the Alarm Silence/Reset button while the LED is lit will cancel the alarm silence period and reset all alarms.

NOTE: If the Alarm Silence/Reset switch is activated when alarm conditions are not present but visual indicators from previous alarms are present, the visual indicators will reset and the Silence LED will not light. A silence period cannot be activated unless an audible alarm is present.

3.3.4 I:E Ratio Alarm

This alarm notifies the user when settings of Inspiratory Time or Tidal Volume, Flow and Breath Rate cause inspiratory time to exceed 50% of the total breath period as defined by the Breath Rate control. When this condition occurs, the ventilator flashes IE on the monitor display, limits inspiratory time to 50% of the total breath and sounds an audible alarm. The visual and audible alarms cannot be canceled until the alarm condition is corrected.

3.3.5 Apnea Alarm

The Apnea Alarm is located on the front panel, as designated by item #1, Figure 3.1, Front Panel Illustration. The alarm activates audible and visual alarms when the period between any two consecutive inspiratory starts exceeds 20 seconds. This also initiates Apnea Backup Ventilation (refer to Section 4.0: Operating Instructions). Pressing the alarm silence/reset button when the alarm is active will reset the system to normal ventilatory mode.

3.3.6 Disconnect Alarm

WARNING!

- The Low Peak Pressure Alarm should always be set to an appropriate level to alert the operator in the event of a pressure loss.

The Disconnect Alarm is located on the front panel, as designated by item #1, Figure 3.1, Front Panel Illustration. This activates audible and visual indicators if a positive pressure rise of at least 2 cmH_2O above initial inspiratory pressure is not detected during an inspiration period.

Silence	Yes
Silence Interval	30 seconds

3.3.7 Ventilator Inoperative Alarm

The Vent Inoperative LED alarm indicator is located on the front panel and is designated as item #1 on Figure 3.1, Front Panel Illustration. This alarm condition causes the ventilator to cease normal gas delivery and allows a non-apneic patient to breath spontaneously from "room" air. Ventilator Inop alarms fall into two (2) categories: recoverable and non-recoverable. If a recoverable condition exists, the ventilator will return to normal operation once the alarm conditions have been returned to normal. The following are recoverable alarm conditions.

- Loss of electrical power caused by interruptions of the external power.
- Mode switch is momentarily set to the OFF position.
- Power supply voltages out of specified range.

A non-recoverable Ventilator Inop condition is characterized by an audible alarm and illumination of all LED segments in the monitor display (item #8 on Figure 3.1, Front Panel Illustration) and is generally created by a software detection of an out-of-tolerance condition in the ventilator system. A CPU failure alarm is included which activates whenever the CPU fails to successfully complete a self-check at initial power up or detects an operational fault during operation. The ventilator must be turned OFF and the Alarm Silence/ Reset button depressed to silence the audible alarm. To prevent recurrence of the alarm, the condition must be corrected prior to returning the ventilator to normal operation. This alarm cannot be silenced until the condition is corrected or the ventilator mode switch is turned to the "OFF" position and the silence button is depressed.

3.3.8 External Power Low/Fail

The LED indicator for this alarm is located on the front panel (item #1 on Figure 3.1, Front Panel Illustration). This alarm activates when the external power cord is connected to the Avian, and the voltage is out of the specified operating range. The ventilator automatically switches to internal battery power under this condition. This alarm can be silenced and will remain silenced until the internal low battery alarm activates. The Low Battery Alarm will notify the user when the internal battery is near depletion.

Silence	Yes
Silence Interval	Permanent

3.3.9 Battery Low/Fail

The Battery Low/Fail LED alarm indicator is located on the front panel and is designated as item #1 on Figure 3.1, Front Panel Illustration. The alarm activates when no external power is applied and when battery voltage is below 5.6 ±.2 volts. This alarm can be silenced for five (5) minute intervals. The battery life remaining after this alarm is activated is a function of the settings and battery condition.

Silence	Yes
Silence Interval	Five (5) Minutes

3.3.10 PEEP Not Set

The PEEP Not Set LED alarm indicator is located on the front panel and is designated as item #1 on Figure 3.1, Front Panel Illustration. The alarm activates when the monitored PEEP value deviates more than 5 cmH_2O from the manually set PEEP reference level.

Silence	Yes
Silence Interval	30 seconds

3.3.11 Transducer Calibration

Activates during system self-test if the zero baseline pressure exceeds ±2 cmH_2O. The display will alternately flash CAL and FAIL accompanied by an audible alarm. The audible alarm cannot be silenced until the condition is corrected.

If the transducer calibration alarm activates, the unit must be placed in CAL Mode (refer to Section 4.0: Operating Instructions) to recalibrate the transducer.

3.4 MONITORS

3.4.1 Power ON

The Power ON LED indicator is located on the front panel and is designated as item #25 on Figure 3.1, Front Panel Illustration. The indicator is a green LED that illuminates when the mode switch is in any position other than OFF and when sufficient power (internal or external) is present.

3.4.2 External Power

The External Power LED indicator is located on the front panel and is designated as item #26 on Figure 3.1, Front Panel Illustration. The indicator is a yellow LED that illuminates when the power supply cord is connected to an active external power source.

3.4.3 Airway Pressure Monitor

The Airway Pressure Monitor is an LED bar graph indicator. It is located on the front panel and is designated item #11 on Figure 3.1, Front Panel Illustration. It provides a visual display of real time airway pressure by means of a bar graph.

Range	-10 to 100 cmH_2O

3.4.4 Monitor Display

The Monitor Display is a 4 digit, 7 segment LED display. It is located on the front panel and is designated as item #8 on Figure 3.1, Front Panel Illustration. The display is used to display monitored pressures, precise values of control and alarm settings and calibration information.

When the unit is turned ON, the unit monitor will sequentially scroll through current settings for Breath Rate, Tidal Volume, Flow, and High and Low Pressure Alarms.

The LED monitor will display the current numeric setting for the following Controls and Alarms:

- Breath Rate
- Flow
- High Pressure Alarm
- Manual (PEEP) Reference
- Low Pressure Alarm
- Inspiratory Time
- Tidal Volume

The monitor will display the current value for the above functions when the associated Display button is depressed or when the setting is changed. An LED associated with each parameter will illuminate, indicating which parameter is currently being displayed.

The monitor will also display the current data for the pressure monitoring functions. An associated LED will light to show the current parameter being displayed.

3.4.5 Peak Inspiratory Pressure (PIP)

The PIP button is located on the front panel and is designated as item #4 on Figure 3.1, Front Panel Illustration. When the PIP button is depressed, it displays the Peak Inspiratory Pressure for the last breath as monitored by the airway pressure line. This applies to all breath types except Spontaneous.

Range	0 to 100 cmH_2O

3.4.6 Mean Airway Pressure (MAP)

The MAP button is located on the front panel and is designated as item #2 on Figure 3.1, Front Panel Illustration. When the MAP button is depressed, the monitor displays the Mean Airway Pressure over the entire ventilation cycle based on a 40 second average. The display is updated every 8 seconds.

Range	0 to 100 cmH_2O

TABLE 3.1 FRONT PANEL ILLUSTRATION REFERENCE

ITEM NUMBER	DESCRIPTION
1	Alarm Displays, LED (Various)
2	Mean Airway Pressure (MAP) Display Button
3	Alarm Silence/Reset Button
4	Peak Inspiratory Pressure (PIP) Display Button
5	Airway Pressure (Paw) Display Button
6	Low Pressure Alarm Display Button
7	Low Pressure Alarm Control Knob
8	Monitor Display
9	High Pressure Alarm Display Button
10	High Pressure Alarm Control Knob
11	Airway Pressure Monitor
12	Mode Selection Control Knob
13	Sigh Control Button
14	Manual Breath Control Button
15	Manual PEEP Reference Button
16	Assist Sensitivity Control Knob
17	Breath Rate Display Button
18	Breath Rate Control Knob
19	Tidal Volume/Inspiratory Time Control Knob
20	Inspiratory Time Display Button
21	Tidal Volume Display Button
22	Flow Control Knob
23	Flow Display Button
24	Pressure Relief Control Knob
25	Power "ON" Indicator LED
26	External Power Indicator LED

FIGURE 3.2 PNEUMATIC AND EXTERNAL POWER CONNECTION ILLUSTRATION

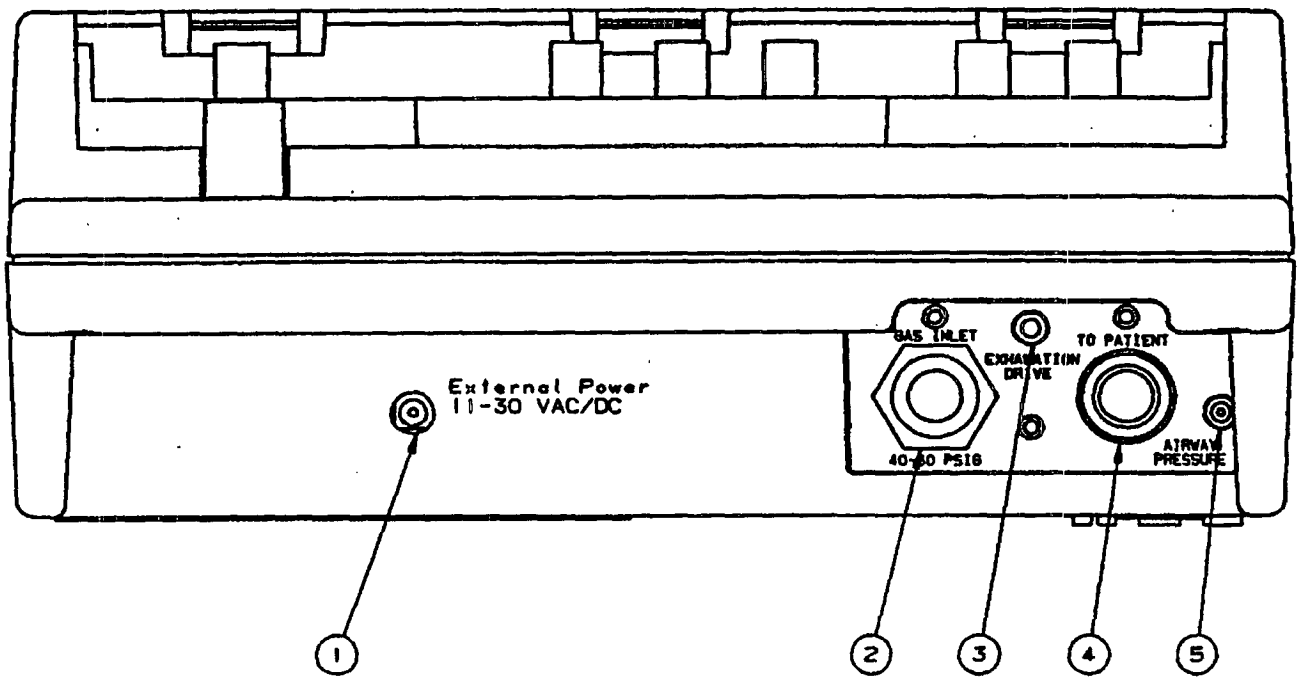


TABLE 3.2 PNEUMATIC AND EXTERNAL POWER CONNECTIONS ILLUSTRATION REFERENCE

ITEM NUMBER	DESCRIPTION
1	11-30 VAC/DC External Power Input Jack
2	40-60 PSI Gas Supply Inlet
3	Exhalation Valve Drive Line Connection
4	Patient Gas Outlet Port
5	Proximal Pressure Line Port

Figure 3.3: Patient Valve Illustration

FIGURE 3.3 PATIENT VALVE ILLUSTRATION

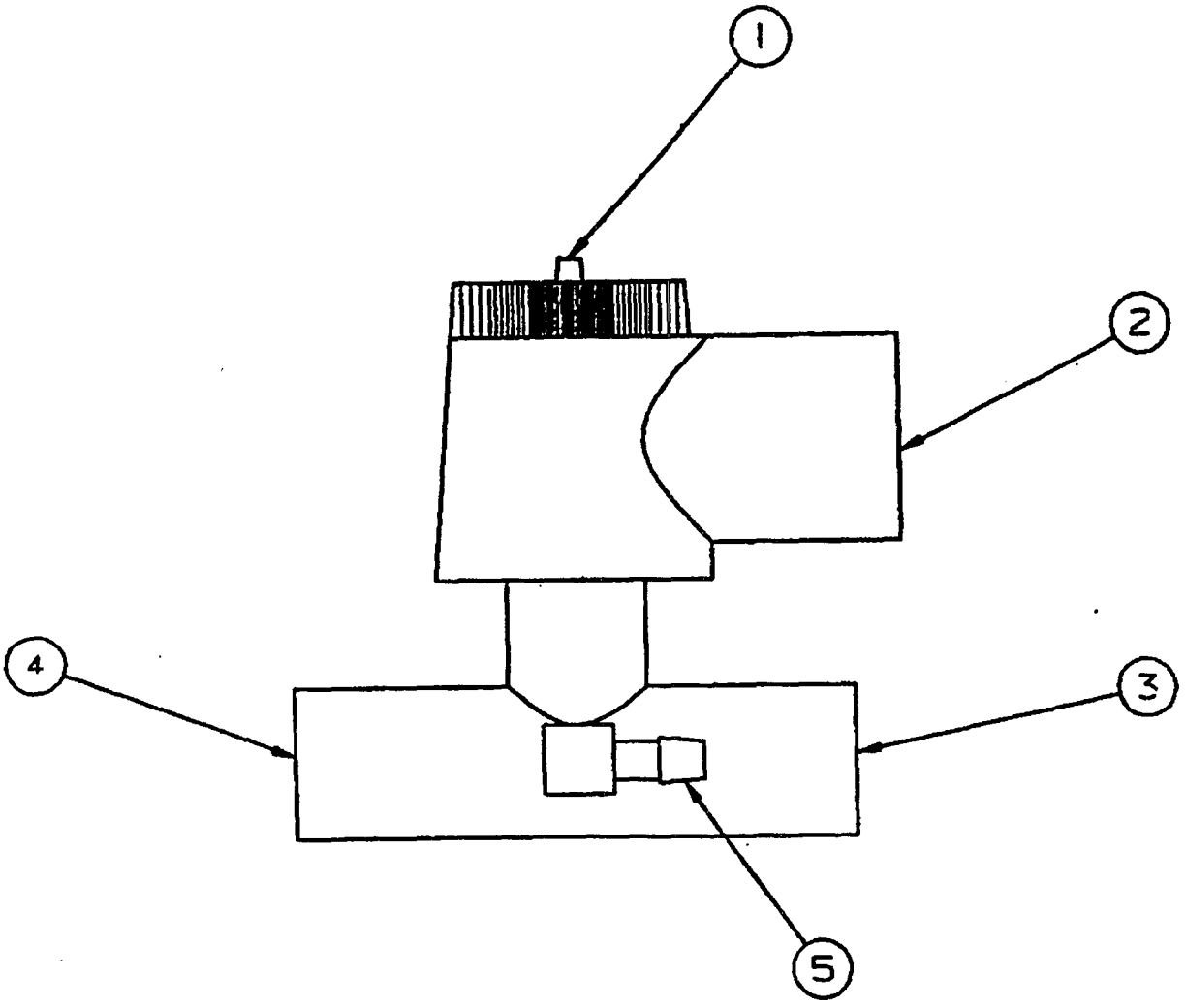


TABLE 3.3 PATIENT VALVE ILLUSTRATION REFERENCE

ITEM NUMBER	DESCRIPTION
1	Exhalation Drive Port (1/8")
2	30mm Exhalation Outlet Port
3	Gas Inlet Port
4	22mm Patient Connection
5	Proximal Pressure Line Port (3/16")

AVIAN TRANSPORT VENTILATOR

SECTION 4.0: OPERATING INSTRUCTIONS

4.1 INTRODUCTION

WARNING !

- Before using the Avian Transport Ventilator, the user should read and understand all warnings and cautions in Section 2.0 of this manual.

4.2 ASSEMBLY INSTRUCTIONS

Remove the unit from the shipping container and check to ensure that there is no visible damage to the unit.

Connect the gas supply to the GAS INLET port (item #2 on Figure 3.2, Pneumatic and External Power Panel Illustration) with the appropriate high pressure hose. If using a Bird blender, attach the air and oxygen hose assemblies to the appropriate gas sources, and connect a high pressure supply hose from the blender outlet to the GAS INLET port on the ventilator.

WARNING !

- The compressed gas source must be between 40 and 60 PSI and be able to deliver a minimum of 100 lpm flow.

The GAS INLET port contains an integral filter which is designed to stop occasional particals present in a clean medical grade gas supply. If operating the ventilator from any gas supply other than clean "medical grade", Bird Products recommends using an external auxillary filter.

WARNING !

- If an external auxillary filter is unavailable or cannot be used, the Avian Transport Ventilator inlet filter must be frequently checked for build-up of debris. Filter elements contaminated with moderate amounts of debris should be immediately replaced to avoid the possibility of a ventilator malfunction.

Connect the patient tubing to the ventilator outlet port marked TO PATIENT (item #4 on Figure 3.2, Pneumatic and External Power Panel Illustration), and connect the opposite end to the gas inlet port (item #3 on Figure 3.3. Patient Valve Illustration) on the patient valve.

Connect the smaller 1/8" CLEAR tube between the EXHALATION DRIVE (item #3 on Figure 3.2, Pneumatic and External Power Panel Illustration) on the ventilator and the exhalation port (item #1 on Figure 3.3, Patient Valve Illustration) on the patient valve.

Connect the larger 3/16" CLEAR tube between the AIRWAY PRESSURE line port (item #5 on Figure 3.2, Pneumatic and External Power Panel Illustration) on the ventilator and the pressure line port (item #5 on Figure 3.3, Patient Valve Illustration) on the patient valve.

If a humidifier is used, follow the manufacturer's instructions for use. If the ventilator is to be powered from an external power source, connect the AC power supply adapter or the 12 VDC power cable from the external power source to the ventilator EXTERNAL POWER input jack, (item #1 on Figure 3.2, Pneumatic and External Power Panel Illustration).

NOTE: The AC power supply adapter is preset for 115 VAC/50-400 Hz operation. If 230VAC/50-400 Hz use is required, the switch located on the AC adapter must be repositioned to the correct setting in order for the unit to function properly.

If the ventilator is to be operated from the internal battery, no power connections are necessary; however, please refer to Section 8.0: Maintenance and Service for proper battery care instructions.

4.3 PERFORMANCE CHECK

WARNING !

- If the Avian Transport Ventilator fails the Performance Check, do not attempt to operate the ventilator until the performance specifications have been restored and verified.

4.3.1 Preparation

Assemble the breathing circuit and attach it to the ventilator as described in Section 4.2, page 4-1 of this manual.

NOTE: Remove the PEEP valve from the exhalation valve. If the removable PEEP valve is attached prior to this point and has a setting greater than 2 cmH_2O, the system will fail the start-up self-test.

Attach a high pressure supply hose from the external gas source to the ventilator gas inlet port as described in Section 4.2, page 4-1 of this manual.

If an external power source is available, connect the external AC power supply to an AC power outlet and to the external electrical receptacle on the Avian Transport Ventilator.

4.3.2 Internal Self Test

Place the MODE SWITCH to Control. At this point, the ventilator will begin a self-test. The power up self-test is performed before power is supplied to the ventilator control systems.

During the self-test, the following test sequence occurs:

- Audible Alarm Sounds
- All LED indicators ON
- Memory Test
- EPROM Check Sum Test
- External Power
- Battery Status
- Pressure Transducer Verification
- All LED Indicators OFF
- Displays current settings for Breath Rate, Flow, Tidal Volume, High and Low Pressure Alarms
- Audible Alarm Ceases

If the self-test detects a failure in any one of the above sequences, a CPU failure alarm will activate. This alarm cannot be silenced or canceled unless the unit is turned OFF. If the test detects no failures, the system will become operational.

Once the self-test is completed, attach a test lung (P/N 04845 or equivalent) to the patient connection (item #4 on Figure 3.3, Patient Valve Illustration) on the patient valve.

Connect the removable PEEP valve to the 30mm exhalation outlet port (item #2 on Figure 3.3, Patient Valve Illustration) on the patient valve.

4.3.3 Test Settings

NOTES:
- The operational parameter settings called out in this section are only for the Performance Check.
- Press the Paw button to monitor the PEEP level.

CONTROL	PARAMETER SETTING
Breath Rate	12 bpm
Inspiratory Time	1.0 Second
Flow	30 lpm
Pressure Relief Valve	Maximum (full clockwise)
PEEP Valve	10 cmH_2O

ALARM PARAMETER	SETTING
High Peak Pressure alarm	Press the PIP button to obtain the peak pressure. Set the alarm 5 cmH_2O above the peak pressure up to the maximum of 100 cmH_2O.
Low Peak Pressure alarm	Set the alarm 10 cmH_2O below the peak pressure up to the maximum of 50 cmH_2O.

4.3.4 Testing

SET CONTROL	ANTICIPATED REACTION
Set Breath Rate to 0 Display Paw	The airway pressure should not drop more than 4 cmH_2O over a 15 second period.
Set the Breath Rate to 12 bpm	Return to a 12 bpm Breath Rate

ALARM TEST PROCEDURE	ANTICIPATED REACTION
External Power: If an external power supply is being used, disconnect the power cord from the electrical outlet. Reconnect the power supply cord to the electrical outlet. Press the Silence/Reset button.	The External Power Failure audible/visual alarm will activate, and the ventilator will continue to operate via the internal battery. The audible alarm will cancel. The visual indicator will cancel.

ALARM TEST PROCEDURE	ANTICIPATED REACTION
High Pressure: Lower the High Peak Pressure alarm setting to 5 cmH_2O below the PIP reading.	The High Peak Pressure audible/visual alarm will activate. Inspiration will terminate and the ventilator will cycle into exhalation when the patient airway pressure reaches the High Peak Pressure alarm setting.
Reset the High Peak Pressure alarm to its previous setting.	The audible alarm will cancel.
Press the Silence/Reset button.	The visual indicator will cancel.
Low Pressure/Disconnect: Disconnect the test lung from the patient valve.	The Disconnect and Low Peak Pressure audible/visual alarms will activate.
Reconnect the test lung to the patient valve.	The audible alarm will cancel when the ventilator cycles.
Press the Silence/Reset button.	The visual indicators will cancel.
I:E Ratio Alarm: Adjust the Inspiratory Time control knob to a full clockwise position.	The I:E Ratio audible/visual alarm will activate immediately. (The High Peak Pressure alarm may also activate.)
Reset the Inspiratory Time control to 1.0 second.	The I:E Ratio alarm condition will cancel.
Press the Silence/Reset button.	Any active visual alarm indicators will cancel.
Apnea Backup Alarm: Set Breath Rate to 0.	After a 20 second interval has elapsed, the Apnea audible/visual alarm will activate. The ventilator will begin delivering controlled breaths.
Return the breath rate control to 12 bpm. Press the Silence/Reset button.	The audible/visual alarm will cancel.
PEEP Not Set: Press the Manual PEEP Reference button and hold this control until the value scrolls to 16 cmH_2O.	The PEEP Not Set audible/visual alarm will activate.
Adjust the Manual PEEP Reference back to automatic by depressing and holding the button until "A XX" appears in the monitor window ("XX" represents the value of PEEP measured by the ventilator).	The audible alarm will cancel.
Press the Silence/Reset button.	The visual indicator will cancel.

4.4 START-UP INSTRUCTIONS

WARNINGS !

- The Avian Transport Ventilator is a restricted medical device. It is intended to be operated by qualified medical personnel under the direction of a physician.
- When the ventilator is connected to a patient, it is recommended that a trained clinician be in attendance at all times to take prompt action should an alarm or other indication of a problem occur.

4.4.1 Ventilator Setup

Assemble the ventilator system as described in Section 4.2, page 4-1. If using a Bird blender, attach the air and oxygen hose assemblies to the appropriate gas sources. If required, turn supply source valves open and check supply pressure. If using a humidification device to humidify the inspired gas, follow the manufacturer's operating instructions. If using an external power supply, connect the electrical AC power adapter to a properly grounded electrical outlet. Turn unit ON by switching the Mode control from the OFF position to the applicable ventilation mode.

4.4.2 Description of Ventilator Modes

4.4.2.1 Control Mode

All parameters of the delivered breath are controlled by the ventilator. The breath is initiated according to the Breath Rate control. Gas is then delivered to satisfy the requirements of the Flow and Inspiratory Time or Tidal Volume settings. The sensitivity control is non-operational in the Control mode.

4.4.2.2 Assist/Control

This mode allows the delivery of either a Controlled or an Assist/Controlled breath type. In effect, the patient is allowed to augment breath rate, but not flow or tidal volume/ inspiratory time. When this mode is selected, a visual indicator will light notifying the user that the patient trigger function is active. In the Assist/Control mode, the patient is able to initiate an Assist/Controlled breath if both of the following conditions exist:

- The ventilator is not currently in inspiration or the minimum exhalation phase, and;

- The patient inspiratory effort exceeds the Sensitivity trigger setting. After the initiation of a breath, gas is delivered to the patient in accordance with the Control settings. The patient is not permitted to augment the flow in this mode.

4.4.2.3 SIMV

In the SIMV (Synchronized Intermittent Mandatory Ventilation) mode, all control parameters are used, with PEEP and Sigh as optional controls. Depending on the control settings, ventilation can be totally patient controlled, or totally machine controlled with varying degrees of ventilator support between spontaneous breaths.

There are two (2) types of breath periods in SIMV, both defined by the Breath Rate control. They are Spontaneous Breathing present, and Spontaneous Breathing not present.

- **Spontaneous Breathing is present:**

An "assist window" is opened at the beginning of a breath period. If a patient effort is detected (defined by the Sensitivity control), an Assist/Controlled breath is delivered in accordance with the ventilator settings. The patient is then allowed to breath spontaneously for the remainder of the breath period. At the beginning of the next breath period, the assist window is reopened. If patient effort is detected, an Assist/Controlled breath is delivered and the cycle repeats.

- **Spontaneous Breathing is not present:**

Following a complete breath period wherein spontaneous breathing is not present, at the beginning of the next breath period the ventilator will deliver a mandatory Controlled breath as determined by the ventilator settings. The assist window will then be immediately opened. If a patient effort is detected, an Assist/Controlled breath will be delivered. The patient is allowed to breath spontaneous for the remainder of the breath period. The next breath period will be as described in the "Spontaneous Breathing is present" paragraph.

4.4.2.4 CPAP Mode

In CPAP mode, the patient is allowed to breath spontaneously over an elevated baseline pressure. All breaths are completely patient controlled. This mode is accessed by turning the Breath Rate control to "0" and adjusting the external PEEP valve to a level appropriate for the clinical situation.

Tidal Volume or Inspiratory Time and Flow should be adjusted to appropriate levels for adequate minute ventilation should the patient become apneic and the ventilator reverts to Apena Back-Up ventilation.

4.4.2.5 CAL Mode

NOTE: Prior to entering CAL Mode, the patient should be disconnected from the ventilator and the patient port should be open.

Upon entering CAL mode a display test will activate, illuminating specific LEDs. This function allows the user to verify the operation of membrane switches and associated LEDs. These LEDs will be Illuminated:

- PEEP Not Set
- Apnea
- Battery Low/Fail
- External Power Fail
- Disconnect
- Power
- External Power (If Present)
- All segments of the Airway Pressure Bar Graph

Membrane switches, when pressed, will cause the associated LED to illuminate. Switches that have associated variable controls or alarms will display the value on the Monitor Display when the switch is pressed. The range and operation of the control can be checked by rotating the associated control through its range after the switch is pressed.

In CAL Mode, the ventilator will monitor the airway pressure transducer output for a maximum of 3 seconds. If the measured reading is within ±4 cmH_2O of 0, the unit will store this offset and will add or subtract it from the pressure reading during normal operation to obtain corrected pressure. The unit will display PASS to indicate that the calibration has been successfully completed, and the unit can be returned to normal operation. If the measured reading is greater than ±4 cmH_2O, the unit will sound an audible alarm and flash FAIL in the LED display. The unit will not store this value, and if returned to normal operation the unit will not apply an offset to the pressure transducer signal. Causes for CAL failure are excessive transducer drift and/or patient port not open.

4.4.2.6 OFF Setting

When the Mode Control is in the OFF position, all controls, settings and alarms, except the Ventilator Inop Alarm, are deactivated and are rendered non-operational.

To stop operations of the Avian Transport Ventilator, turn the Mode Control to the OFF position and press the Alarm Silence/Reset button. The visual inoperative light will continue to flash for approximately 30 minutes.

4.5 APNEA BACKUP VENTILATION

This is an automatic function of the Avian Transport Ventilator.

If the time between patient initiated breaths exceeds the 20 second Apnea Interval, the ventilator will automatically revert to the Assist/Control mode of ventilation. An audible alarm will sound, and the visual Apnea Alarm indicator will flash. The breath rate will be 12 BPM. Apnea Backup Ventilation can be terminated by clearing the Apnea Alarm with the Alarm Silence/Reset button. The Apnea Backup Alarm is not mutable.

4.6 CLINICAL OPERATION OF CONTROLS

4.6.1 Mode

Adjust the Mode selection control to the appropriate position for Control, Assist/Control, SIMV, or CPAP.

4.6.2 Inspiratory Time/Tidal Volume

NOTE: Volume Cycled ventilation is the default form of ventilation. If the ventilator has been turned off, it will always revert to Volume Cycled ventilation when turned on.

This is a multiplexed control that allows for direct setting of Tidal Volume for volume cycled ventilation or Inspiratory Time for time cycled ventilation. Selection of **Volume** cycled ventilation or **Time** cycled ventilation is made by depressing the **Tidal Vol.**, or **Insp. Time** button.

Once a selection is made (Tidal Vol. or Insp. Time), a transition phase is initiated, and the setting for the new type of ventilation will flash in the monitor window. During this transition phase, the ventilator will continue to ventilate the patient based on the former type of ventilation and at the former setting. The operator can adjust the new setting to the desired level.

The new type of ventilation must be activated by performing one of the following two actions:

A) Pressing the Display button for that control (Insp. Time or Tidal Volume) a second time.

In this case, the value displayed in the monitor window will cease flashing and will be displayed continuously.

or

B) Adjusting the new setting for the new type of ventilation (Insp. Time or Tidal Volume), then adjusting the setting of, or pressing the Display button for another parameter on the ventilator (High Pressure Limit, Low Peak Pressure, Breath Rate, Flow, Manual PEEP Ref., MAP, PIP or Paw)

In this case, the value for the selected parameter (High Pressure Limit, Low Peak Pressure, Breath Rate, Flow, Manual PEEP Ref., MAP, PIP or Paw) will be displayed in the monitor window.

NOTE: To activate the new form of ventilation under Section 4.6.2.B, an adjustment must be made to the new type of ventilation **(Insp. Time or Tidal Volume)** before adjusting the setting of, or pressing the display button of the listed parameters.

WARNING !

- In order to activate the newly selected form of ventilation, the operator must perform one of the actions outlined in Section 4.6.2. A or B. Failure to do so will result in the ventilator continuing to operate under the previous settings and previous type of ventilation.

If, during the transition phase, the new setting will cause an inverse I:E ratio state, the ventilator will alternately flash "XXX" and "-IE" with "XXX" representing the Tidal Volume or Inspiratory Time setting. An audible alarm will be sounded if the new form of ventilation is activated in this condition.

Should the operator wish to revert to the original form of ventilation during the transition phase, this can be done by depressing the display button for the original form of ventilation and following the same procedure outlined in Section 4.6.2. A or B.

NOTE: The Tidal Volume and Inspiratory Time controls are completely independent and do not correspond to each other.

4.6.3 Breath Rate

Adjust to the appropriate setting to establish the minimum number of machine breaths per minute.

4.6.4 Flow

Adjust to the appropriate setting to establish the peak level of gas flow during a machine controlled and/or assisted breath and for Apnea Backup Ventilation.

4.6.5 Sensitivity

Adjust to the appropriate level to determine the threshold level at which an assisted or a spontaneous breath will be initiated.

4.6.6 PEEP/CPAP

PEEP is provided by a removable PEEP valve located at the patient valve. Adjust the PEEP valve to establish the baseline pressure for all breath types.

4.6.7 Manual PEEP Reference

An external PEEP valve is used to establish elevated baseline pressures on the Avian Transport Ventilator. As stated in Section 3.2.5 on page 3-4, the ventilator is PEEP compensated. The level of PEEP set at the external PEEP valve is automatically recognized by the ventilator through the monitoring of the airway pressure. This information, used in conjunction with the Sensitivity setting, determines the level at which an assisted or spontaneous breath is triggered. The level of PEEP read by the ventilator for triggering assisted and spontaneous breaths can also be set manually via the Manual PEEP Reference function.

By depressing the Manual PEEP Reference button, an LED indicator is illuminated and the current level of PEEP measured by the ventilator is displayed in the monitor window. The display will read "A XX" where "A" indicates that the unit is automatically measuring the PEEP level set at the external PEEP valve, and "XX" is the value of PEEP the ventilator is measuring. Holding the button depressed for longer than 3 seconds will cancel this automatic function and initiate scrolling of the display from 0 to 20 cmH_2O. Releasing the button will freeze the display at the current setting, and the ventilator will use this value as its reference level of baseline pressure for triggering assisted and spontaneous breaths. The LED indicator will remain lit for as long as the Manual PEEP Reference function is active.

To deactivate the Manual PEEP Reference and return to the automatic measurement of PEEP, depress the button and keep it depressed until the LED displays an "A O". Releasing the button at this point reactivates the automatic PEEP reference function.

4.6.8 Sigh ON/OFF

Depress the Sigh button to deliver a Sigh breath in the next breath cycle. An LED will light indicating that Sigh has been activated. A sigh breath will continue to be delivered once every 100 breaths or 7 minutes, whichever comes first, regardless of breath type.

Sigh can be deactivated by depressing the Sigh button again, at which point the LED indicator will extinguish.

4.6.9 Manual Breath

Depress this button to deliver one machine controlled breath in accordance with the current Flow and Inspiratory Time or Tidal Volume settings. A manual breath will not be delivered if activated during an inspiratory or minimum exhalation phase of a breath cycle of any breath type.

4.6.10 Pressure Relief Valve

Turn the control knob clockwise (increase) or counterclockwise (decrease) to set the appropriate maximum allowable pressure in the patient circuit. This function can be used as an added safety feature to the High Peak Pressure Alarm.

To use the Pressure Relief Valve as an added safety feature set the control 5 - 15 cmH_2O (or according to hospital protocol) above the High Peak Pressure Alarm. This can be accomplished by attaching a Bird test lung (P/N 04845 or equivalent) to the patient circuit and turning the High Peak Pressure alarm to MAXIMUM (100 cmH_2O). Set the Pressure Relief Valve by depressing the Peak Inspiratory Pressure monitor button (PIP) and viewing the peak inspiratory pressure in the monitor window. Once the desired pressure level is achieved, adjust the High Peak Pressure Alarm 5 - 15 cmH_2O (or to hospital protocol) **below** the pressure level of the Pressure Relief Valve.

4.7 CLINICAL OPERATION OF ALARMS

WARNING !

- It is the responsibility of the clinician or user to establish and monitor the appropriate alarm settings for each patient and mode of ventilation.

4.7.1 High Peak Pressure

Adjust to an appropriate setting higher than the peak pressure reading on the Monitor display to establish the High Pressure limit, above which an audible alarm will sound, inspiration will be terminated and exhalation will begin. This alarm is active for all breath types.

NOTE: The alarm limit is automatically increased by 1.5 times the display setting (up to 100 cmH_2O) during the delivery of a Sigh breath.

4.7.2 Low Peak Pressure

Adjust to an appropriate setting lower than the peak pressure reading on the Monitor display. This alarm is active for Control and Assist/Control breaths.

4.8 CLINICAL OPERATION OF VENTILATION MODES

WARNINGS !

- Consult a qualified physician when using an air/oxygen blender for proper fractional inspired oxygen (FIO_2) concentrations.
- Monitor patient oxygen concentrations at or near the proximal airway. Use a calibrated oxygen analyzer to verify the oxygen concentrations.

4.8.1 Control Mode

Place the Mode Control switch in the Control Position. Adjust the following controls to the appropriate settings as outlined in Section 4.6 on page 4-9. Adjust alarms to the appropriate settings as outlined in Section 4.7 on page 4-13. Verify that the ventilator is functioning properly.

REQUIRED SETTINGS	OPTIONAL SETTINGS
Inspiratory Time/Tidal Volume	PEEP/Manual PEEP Reference
Flow	Sigh ON/OFF
Breath Rate	Pressure Relief Valve

4.8.2 Assist/Control

Place the Mode Control switch in the Assist/Control Position. Adjust the following controls to the appropriate settings as outlined in Section 4.6 on page 4-9. Adjust alarms to the appropriate settings as outlined in Section 4.7 on page 4-13. Verify that the ventilator is functioning properly.

REQUIRED SETTINGS	OPTIONAL SETTINGS
Inspiratory Time/Tidal Volume	PEEP/Manual PEEP Reference
Flow	Sigh ON/OFF
Breath Rate	Pressure Relief Valve
Sensitivity	

3.4.7 Airway Pressure (Paw)

The Paw button is located on the front panel and is designated as item #5 on Figure 3.1, Front Panel Illustration. When the Paw button is depressed, the monitor displays current airway pressure.

Range	0 to 100 cmH_2O

3.4.8 Limits

Limits are used to ensure that ventilation controls cannot be set to values that would exceed the physical capabilities of the ventilator. This is an automatic function of the ventilator, and cannot be controlled by the user. A control that is being limited shall have its indicator LED flash on for approximately 500 milliseconds. The following controls and combinations of controls can result in one or more controls being limited:

3.4.8.1 Breath Rate/Inspiratory Time

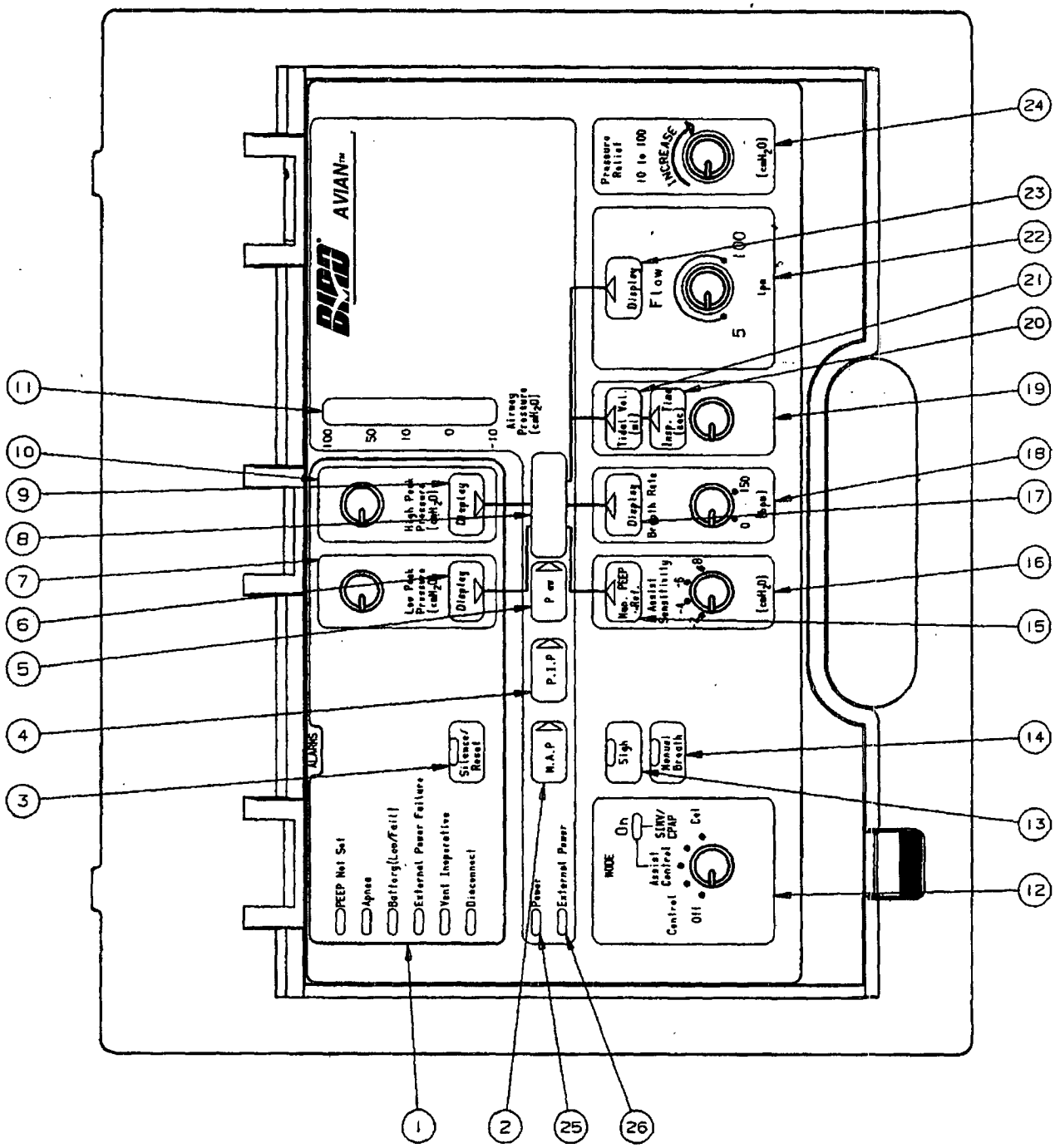
During all modes of ventilation, a minimum exhalation time of 300 milliseconds is required. If the Breath Rate and Inspiratory Time controls are set to a combination of values that mathematically provide an exhalation time shorter than the required minimum, the Inspiratory Time shall be LIMITED to provide a minimum 300 millisecond exhalation time.

3.4.8.2 Tidal Volume/Flow/Breath Rate

During volume modes of ventilation, a minimum exhalation time of 300 milliseconds is maintained. If the Tidal Volume, Flow and Breath Rate controls are set to any combination of values which cause an exhalation time shorter than 300 milliseconds, the Tidal Volume will be LIMITED so that a minimum 300 millisecond exhalation time is provided.

SECTION 3.0: DESCRIPTION OF CONTROLS, ALARMS AND DISPLAYS

FIGURE 3.1 FRONT PANEL ILLUSTRATION



4.8.3 SIMV

Place the Mode Control switch in the SIMV/CPAP position. Adjust the following controls to the appropriate settings as outlined in Section 4.6 on page 4-9. Adjust alarms to the appropriate settings as outlined in Section 4.7 on page 4-13. Verify that the ventilator is functioning properly.

REQUIRED SETTINGS	OPTIONAL SETTINGS
Inspiratory Time/Tidal Volume	PEEP/Manual PEEP Reference
Flow	Sigh ON/OFF
Breath Rate	Pressure Relief Valve
Sensitivity	

4.8.4 CPAP

Place the Mode Control switch in the SIMV/CPAP position. Adjust the Breath Rate control to "0" and adjust the external PEEP valve to an appropriate level.

Adjust the Tidal Volume or Inspiratory Time and Flow controls to levels which will allow for adequate minute ventilation should the patient become apneic and the ventilator revert to Apnea Back-Up ventilation.

Adjust alarms to the appropriate settings as outlined in Section 4.7 on page 4-13. Verify that the ventilator is functioning properly.

REQUIRED SETTINGS	OPTIONAL SETTINGS
Sensitivity	Manual PEEP Reference
Breath Rate	Sigh ON/OFF
PEEP	
RECOMMENDED SETTINGS *(For Apnea Back-Up ventilation)*	
1) Inspiratory Time/Tidal Volume 2) Flow	

4.9 HIGH ALTITUDE OPERATION

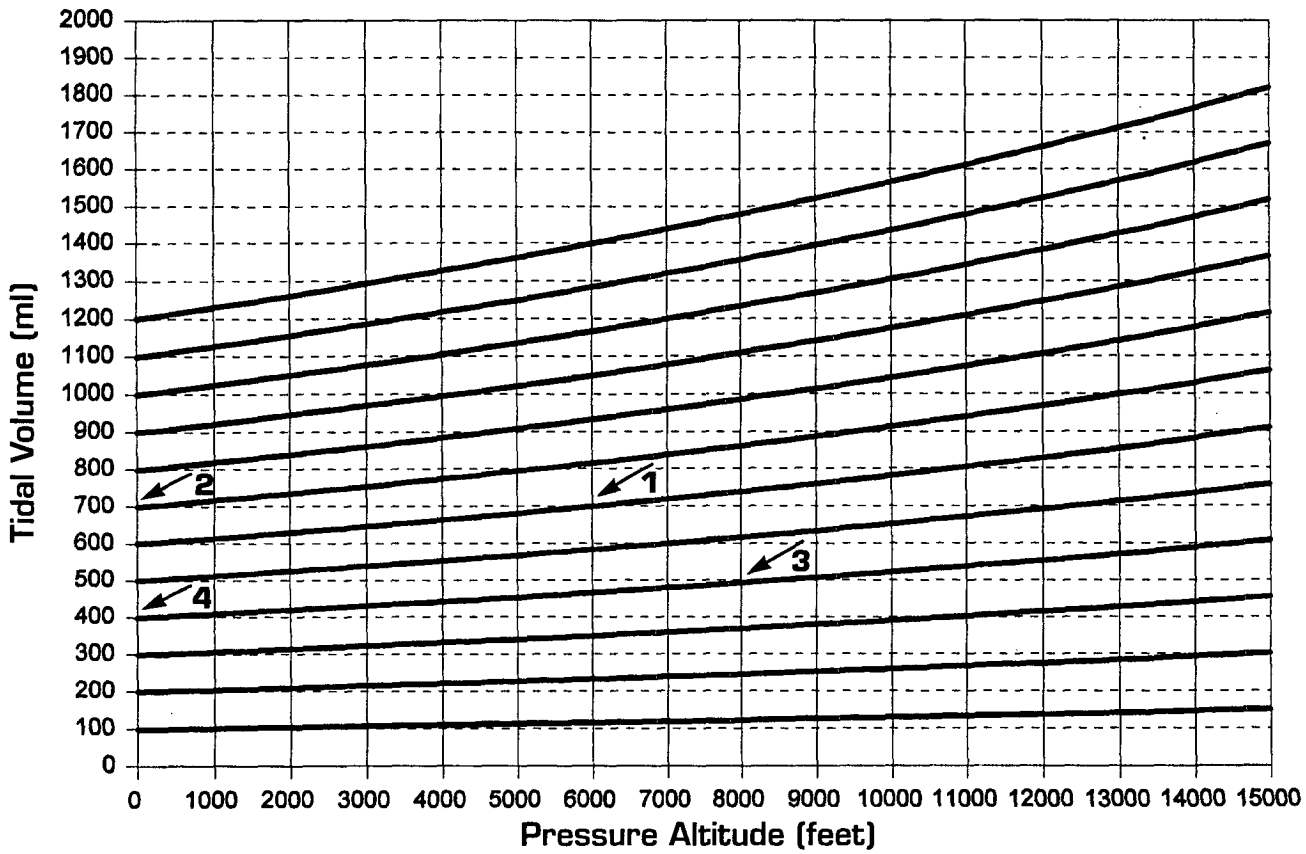
CAUTION ✔

✔ The flow control valve of the Avian Transport Ventilator provides a constant mass flow for each breath, whether at ground level or in an aircraft. The lower ambient pressure at altitudes above ground level will cause the air to assume a larger volume. In other words, the actual volume delivered by the ventilator at altitudes above ground level will be greater than the tidal volume displayed on the unit. The actual volume delivered by the Avian Transport Ventilator can be calculated from the displayed tidal volume and pressure altitudes as shown in the Volume vs. Pressure Altitude Chart, Figure 4.1 on page 4-17.

The Volume vs. Pressure Altitude Chart, Figure 4.1 on page 4-17 can be used to determine the tidal volume corrected for altitude. For example, if the Avian Transport Ventilator tidal volume is set for a 600 ml breath, at 6000 feet pressure altitude (1), the actual tidal volume is determined by following the volume-pressure line. In this case, the 600 ml setting will deliver tidal breaths of 702 ml (2). If a 500 ml (3) tidal volume breath is desired at 8000 feet pressure altitude, then the ventilator should be set to deliver 404 ml (4). Care must be taken in determining the altitude in a pressurized aircraft since the cabin altitude is usually significantly lower than the flight altitude. The correction should be for the ambient altitude (pressure) where the Avian Transport Ventilator is used.

Figure 4.1 VOLUME VS PRESSURE ALTITUDE CHART

NOTE: The Volume vs. Pressure Altitude Chart is provided as an estimation of various changes in volume at various levels of altitudes. This chart is an approximation and volume should be verified through a volume monitoring device.



AVIAN TRANSPORT VENTILATOR

SECTION 5.0: CLINICAL TROUBLESHOOTING

5.1 INTRODUCTION

This section consists of the Operator Troubleshooting Chart.

WARNING !

- Technical repairs should be accomplished by qualified personnel, trained either by Bird Products Corporation or their authorized trainers. BIRD PRODUCTS CORPORATION IS NOT RESPONSIBLE FOR UNAUTHORIZED REPAIRS, OR REPAIRS MADE BY UNAUTHORIZED PROCEDURES.

5.2 OPERATOR TROUBLESHOOTING CHART

Symptom	Potential Cause	Corrective Action
Battery Low/Fail audible and visual alarm present.	The battery is discharged.	Recharge or replace the battery.
Battery Low/Fail visual alarm present.	The battery is below acceptable charging level or the battery has a shorted cell.	Replace the Battery.
CAL visual is flashing on the display with an audible alarm present.	The airway pressure transducer is out of calibration. Patient circuit is not open to ambient.	Calibrate the airway pressure transducer in the CAL mode. Open patient circuit to ambient.
Disconnect audible and visual alarm present.	Leaks or disconnect in the patient circuit and/or humidifier. Loss of gas supply.	Check for leaks and/or disconnects. Re-establish gas supply.
Error Code is displayed on the display monitor.	This indicates there is a problem with the Main Printed Circuit Board.	Return the ventilator to an authorized technical service facility.
External Power Fail audible and/or visual alarm present.	No power to the external power adapter. External power adapter's line selector switch set to the wrong voltage. External power adapter is not connected to the ventilator.	Restore the external power. Set the line selector switch to the proper line voltage. (115 or 230 VAC). Connect the external power adapter to the ventilator.

SECTION 5.0: CLINICAL TROUBLESHOOTING

Symptom	Potential Cause	Corrective Action
FAIL visual is flashing on the display with an audible alarm present.	The patient circuit was not disconnected during the initial power on self test.	Disconnect the patient circuit and momentarily turn the Mode Control switch to the Off position.
High Peak Pressure audible and/or visual alarm present.	Endotracheal tube occlusion. Alarm set below actual peak pressure. Change in patient compliance. Change in ventilation parameters. Obstructed or kinked exhalation drive line.	Check patient status. Readjust the alarm limit. Check patient and readjust alarm. Readjust the alarm setting. Check and clear the exhalation line.
I:E Ratio audible and/or visual alarm present.	Inspiratory time is set to greater than 50% of breath period. Breath Rate is set too high to allow 50% of period for the exhalation phase.	Readjust the Inspiratory time or the breath rate.
Low Peak Pressure audible and/or visual alarm present.	Change in patient compliance. Leaks or disconnect in the patient circuit and/or humidifier. Alarm set too high. Loss of gas supply.	Evaluate patient status. Check for leaks and/or disconnects. Readjust the alarm setting. Re-establish gas supply.
Flow or Volume delivery is low.	The input gas pressure is not within the specified operating range of 40 to 60 psig. The flow control system is out of calibration.	Connect the ventilator to an inlet gas source that is in the 40 to 60 psig range. Return the ventilator to an authorized technical service facility for calibration.

Symptom	Potential Cause	Corrective Action
Vent Inop audible and/or visual alarm present.	No power to the external power adapter.	Restore the external power.
	External power adapter is not connected to the ventilator.	Connect the external power adapter to the ventilator.
	Internal battery is discharged.	Recharge the battery.
	System or CPU failure.	Return the ventilator to an authorized technical service facility.
Ventilator will not power up. No lights visible or audible alarms present.	No power to the external power adapter.	Restore the external power.
	External power adapter is not connected to the ventilator.	Connect the external power adapter to the ventilator.
	Internal battery is discharged.	Recharge the battery.

AVIAN TRANSPORT VENTILATOR

SECTION 6.0: CLEANING AND STERILIZATION

6.1 INTRODUCTION

CAUTIONS ✔

- ✔ Do not sterilize the Avian Transport Ventilator. The internal components are not compatible with sterilization methods.
- ✔ External cleaning and sterilization of the Bird Avian with agents that include phenols, ammonium chloride, chloride compounds and/or those with a greater than 2% concentration of glutaraldehyde are not recommended. These agents may cause damage to plastic components and/or control panel overlays.

6.2 VENTILATOR

The Avian Transport Ventilator should be kept clean and free of dirt at all times. Exposed parts and surfaces should be dried and cleaned if used in wet environments. Grease, dirt and oil should be prevented from entering the system or its components.

The exterior of the ventilator may be wiped clean with an appropriate bacterial or germicidal agent. If cleaning the front panel of the ventilator (underneath the protective clear cover), care should be taken not to allow liquid cleaning agents to pool in or around the controls. This will help minimize the potential for the liquid to penetrate the inside of the ventilator.

- **DO NOT** use harsh abrasives on the ventilator.
- **DO NOT** immerse the ventilator in liquid decontamination agents.
- **DO NOT** sterilize the ventilator.
- **DO NOT** allow bacterial or germicidal cleaning agents to pool on the front panel of the ventilator.
- **DO NOT** spray cleaning solution into any of the ventilator openings.

SECTION 6.0: CLEANING AND STERILIZATION

6.3 PATIENT VALVE ASSEMBLY

Care should be exercised in cleaning the exhalation valve assembly. The exhalation valve is compatible with liquid agents, ethylene oxide (ETO) sterilization, or steam autoclave. If using a liquid agent to clean the patient valve, visually inspect all surfaces to ensure that all cleaning solution has been removed prior to placing the valve back into service.

6.4 BREATHING CIRCUIT

The ventilator breathing circuit, not including any accessories (such as a humidifier), may be sterilized with liquid agents, ETO sterilization or steam autoclave. The reusable 1/8" and 3/16" tubing can be sterilized by being submersed in liquid agents, ETO sterilization or steam autoclave.

6.5 PEEP VALVE

The PEEP valve may be sterilized with liquid agents, ETO sterilization or steam autoclave.

AVIAN TRANSPORT VENTILATOR

SECTION 7.0: OVERVIEW OF SYSTEM OPERATION

7.1 INTRODUCTION

The Avian Transport Ventilator is an electronically controlled, pneumatically actuated ventilator, which can support many of the current modes of ventilation used for adult and pediatric patients. The unit can operate from a wide range of DC and AC power sources, and requires a gas source at 40 to 60 PSI. The electronic control system is microprocessor based, and interfaces to the pneumatic ventilation system through a series of solenoid valves and a pressure transducer. The ventilator uses an exhalation valve and PEEP valve to complete the ventilation system and can also be equipped with an external air/oxygen blender to provide variable oxygen concentrations.

The following theory of operation described in Section 7.2 refers to the Pneumatic Schematic, Figure 7.1 on page 7-7.

7.2 THEORY OF OPERATION

7.2.1 Gas Inlet and Pressure Conditioning

Air, oxygen, or blended gas from an external blender at 40 to 60 psig is connected to the ventilator O2 DISS gas inlet port. The gas flows to the **PRESSURE REGULATOR** where it is regulated down to 30 psig. This provides a stable pressure supply to the remaining flow control system and insures that the delivery of tidal volumes and demand flow is unaffected by inlet pressure variations.

7.2.2 Main Flow Control System

Gas then flows to the **MAIN SOLENOID VALVE,** which controls the flow of gas for controlled and assist controlled breaths. At the start of inspiration, the valve opens and gas flows through the **FLOW CONTROL VALVE** which throttles the flow to the desired level. The **FLOW CONTROL POTENTIOMETER** is attached to the **FLOW CONTROL VALVE** poppet and senses the valve position. This information is used by the microprocessor to calculate tidal volume. Flow continues through the **CHECK VALVE** and out the inspiratory leg of the patient circuit to the patient. At the end of inspiration, the **MAIN SOLENOID VALVE** closes and stops the gas flow.

7.2.3 Exhalation Valve and Control System

When inspiratory flow is present as described in the previous section, a slight pressure drop exists across the **CHECK VALVE.** The upstream elevated pressure is fed to the **EXHALATION VALVE** balloon through the exhalation valve drive line that closes the **EXHALATION VALVE** at the beginning of inspiration. The balloon has an advantageous area ratio with the seat that, coupled with the elevated pressure, holds the **EXHALATION VALVE** closed during the inspiratory phase. When inspiratory flow is stopped, the exhalation balloon pilot pressure is bled off through the **ORIFICE.**

A removable spring loaded PEEP valve can be attached to the outlet port of the **EXHALATION VALVE** if PEEP is needed.

7.2.4 Demand System

When a spontaneous breath is triggered, the **DEMAND SOLENOID VALVE** opens and gas flows through the valve and the **DEMAND ORIFICE** where it is throttled to 60 LPM.

Gas then flows out through the inspiratory leg of the patient circuit to the patient. Since the flow bypasses the **CHECK VALVE,** the exhalation balloon drive pressure does not rise, leaving the exhalation valve open. Excess flow not demanded by the patient flows out of the **EXHALATION VALVE.** Demand flow stops when airway pressure rises above the reference baseline.

7.2.5 Pressure Relief Function/Anti-suffocation Valve

The pressure relief valve acts as a redundant safety feature or can be used to deliver pressure limiting breaths by establishing the maximum pressure in the patient circuit. If airway pressure exceeds the **PRESSURE RELIEF VALVE** setting, gas is vented to the room and the pressure is held constant at this level. When the inspiratory phase is complete or in case of a malfunction, the ventilator flow is shut off.

In case of a ventilator failure or insufficient ventilatory support, the patient can breathe directly from room air through the **ANTI - SUFFOCATION VALVE.**

7.2.6 Airway Pressure Transducer

Pressure at the patient airway is measured and converted to an electrical analog signal by the **AIRWAY PRESSURE TRANSDUCER.** This pressure is used for the bar graph display, breath triggering, and the pressure alarms.

7.3 ELECTRONIC CIRCUIT DESCRIPTIONS

7.3.1 Power Supply Board

7.3.1.1 Overview

The power supply has four basic functional sections: Input power conditioning, battery charger, charger bypass power, and output voltage regulation. The schematic of this circuit board is found in Section 9.0, Figure 9.5.1 on page 9-27.

7.3.1.2 Input Power Conditioning

External input power is applied through a bridge rectifier that allows application of a DC voltage without regard to polarity. AC voltage is also acceptable because a rectifier rectifies the AC. A capacitor provides the necessary filtering. The input can be DC voltage, (11 to 30 VDC), or an AC Voltage, (11 to 24 VAC, peak to peak). Fuse F700 protects against catastrophic failures such as shorted diodes.

7.3.1.3 Battery Charger

The battery charger is a temperature compensated, current limited, dual-level float charger with a dead cell lockout. The charge cycle normally takes less than 24 hours.

Input power from the external power source turns on the charger. The battery is charged at the trickle current rate until the battery terminal voltage exceeds the charge enable threshold of 3.96 volts. This protects the system against high charging current applied to a battery with a shorted cell, or a battery that is installed backwards.

NOTE: Batteries that do not meet the charge enable criteria (3.96 volts) within 24 hours are probably defective and should be replaced. This condition will be indicated by the front panel Battery Low/ Fail Indicator being lighted while external power is present (even if the front panel Mode switch is in the OFF position).

Once the battery voltage exceeds the charge enable threshold, the battery is placed in the bulk charge state. During the initial stages of charging a discharged battery, the charger may reduce the charge voltage to prevent the charge current from exceeding the 500 mA charge current limit.

The charger will provide currents of zero to 500 mA as required and maintain the regulated standby float voltage. If the battery terminal voltage drops to 90% of the standby float level, the charger will switch back to the bulk charge mode.

7.3.1.4 Charger Bypass Power

The Charger Bypass Power circuit provides power to the ventilator electronics without passing that energy through the battery charger control circuit. This helps improve accuracy of the battery charging process, which helps maximize the battery service life.

7.3.2 Main Printed Circuit Board

7.3.2.1 Overview

The Main Printed Circuit Board contains the circuits used to operate and control the Avian Transport Ventilator. Each of the six (6) sheets contains different elements of the circuit board. Each sheet of the schematic is discussed separately. The schematics are located in Section 9.0 and are numbered Figures 9.3.1 through 9.3.6 on pages 9-9 through 9-19.

7.3.2.2 Sheet 1, Figure 9.3.1

This sheet contains the schematic interconnects between the main board schematic sheets and other system printed circuit boards, switches, and valves.

Main Board Connectors	Connects To
J-1	Display Board
J-2	Power Supply Board
J-3	Membrane Switches
J-400	Demand and Flow Valves
J-246	Flow Valve Potentiometer

7.3.2.3 Sheet 2, Figure 9.3.2

Sheet 2 contains the analog-to-digital converter, the front panel control potentiometers, reference voltage multiplier string, potentiometer reference voltage generators, open potentiometer detector circuits, proximal pressure transducer, and the proximal pressure transducer amplifier.

Since the gain and zero offset are fixed in this circuit and the transducer characteristics vary, the calibration is performed in software by the master calibrate function. This operation is not intended for user access, but may be performed by a trained technician using tools and appropriate test equipment.

7.3.2.4 Sheet 3, Figure 9.3.3

Sheet 3 contains circuits that are not available in the DEPMED version of the Avian Transport Ventilator and are not discussed in this manual.

7.3.2.5 Sheet 4, Figure 9.3.4

Sheet 4 contains the power supply fault monitor circuit, and the valve solenoid drivers.

7.3.2.6 Sheet 5, Figure 9.3.5

The CPU, the Watchdog Timer and PAL, and the crystal clock generator are on this sheet. The CPU, U500, is an 8-bit 80C31. Program Memory is in U504, a 64k-byte 27C512 EPROM.

7.3.2.7 Sheet 6, Figure 9.3.6

Sheet 6 contains the V-BAK supercap backup supply, the alarm driver, the Vent Inop LED driver, and the push-button switch read circu its. The V-BAK supply is based around a super capacitor. This device is used to store energy that is used after a power failure to drive the audible alarm and the Vent Inop LED indicator.

7.3.3 Display Board

Figure 9.4.1 on page 9-23 is the schematic diagram for the Display Printed Circuit Board. This board contains four basic sections: The 4-digit 7-segment numeric display, the twenty-six (26) software controlled alarm LED indicators, a 20-segment bar graph display, and three (3) discrete LED indicators.

The 4-digit 7-segment numeric display is shared by the monitor and display functions to display pressure, volume and flow information. The 20-segment bar graph is dedicated to display patient airway pressure. The software controlled LED indicators display alarm in dicators. The three (3) discrete LED indicators are used to display Power, External Power, and Ventilator Inoperative conditions and are not under software control.

Figure 7.1 PNEUMATIC SCHEMATIC

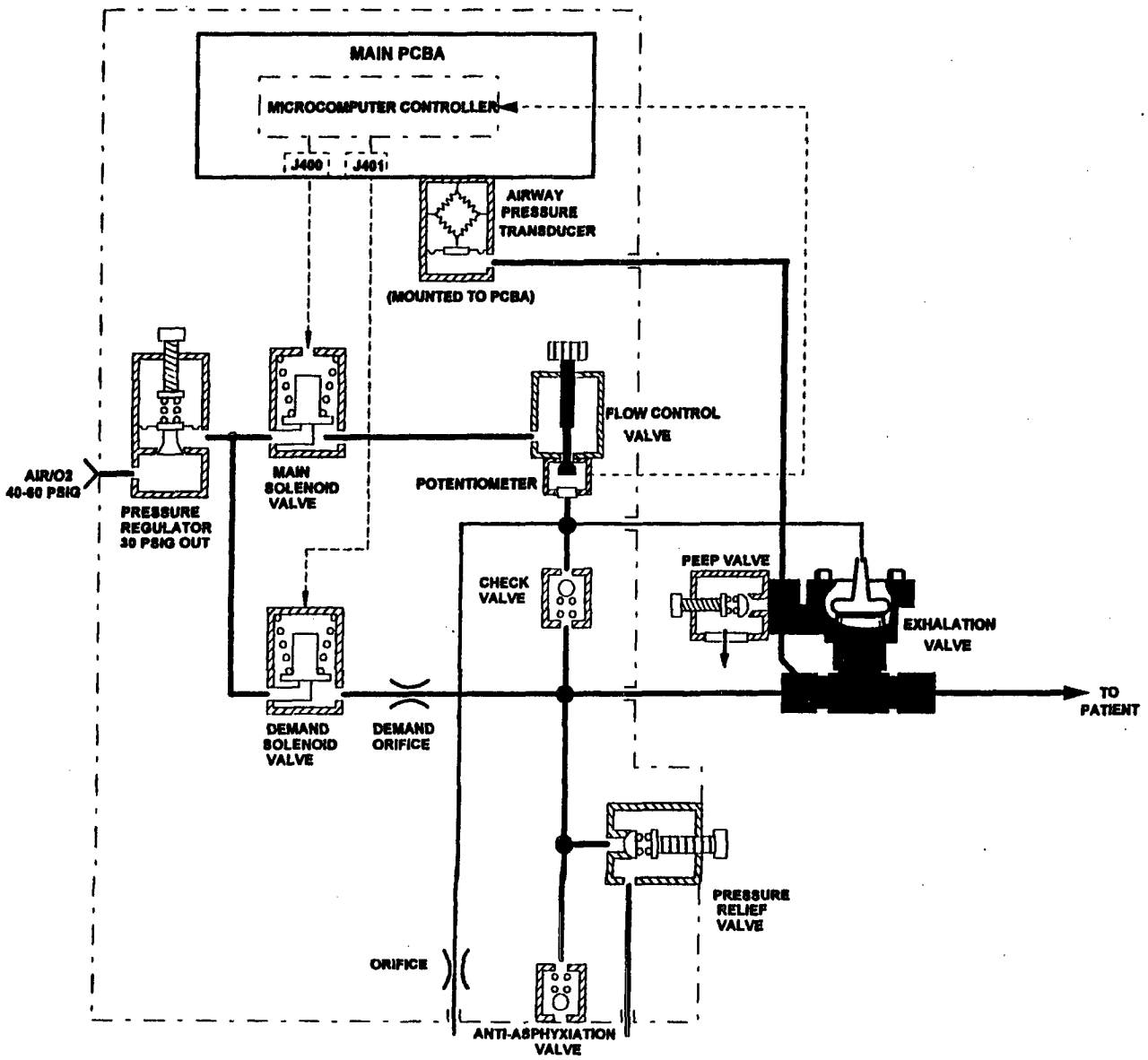
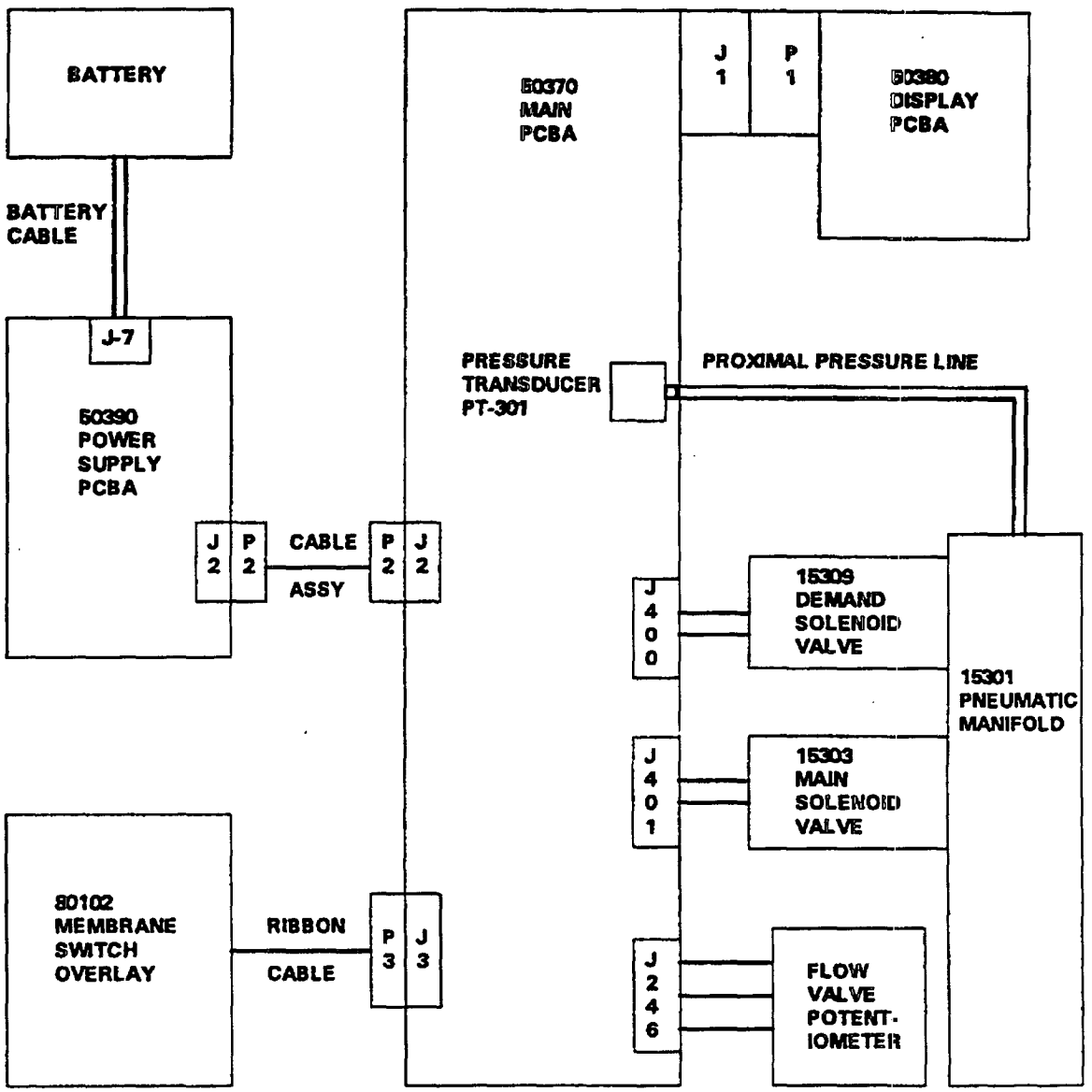


Figure 7.2 ELECTRICAL BLOCK DIAGRAM



AVIAN TRANSPORT VENTILATOR

SECTION 8.0: MAINTENANCE AND SERVICE

8.1 INTRODUCTION

This section includes recommended preventive maintenance procedures, battery care and replacement procedures, a technical troubleshooting chart, and repair and calibration procedures.

WARNINGS !

- Technical repairs should be accomplished by qualified personnel, trained either by Bird Products Corporation or its authorized trainers. BIRD PRODUCTS CORPORATION IS NOT RESPONSIBLE FOR UNAUTHORIZED REPAIRS, OR REPAIRS MADE BY UNAUTHORIZED PROCEDURES.
- The Avian Transport Ventilator must pass a full technical performance check following any repair.

8.2 RECOMMENDED TOOLS AND TEST EQUIPMENT

8.2.1 Special Tools and Test Equipment

The items listed in this table are available from Bird Products Corporation.

Part Number	Description
04845	Test Lung
10333	Patient Circuit Kit

These special items are not available from Bird Products Corporation.

Item	Description
Anti-Static Cable	Anti-Static mat ground connector cable
Anti-Static Mat	Workbench cover
Anti-Static Strap	Wrist strap
Digital Voltmeter	Model 83, Fluke or equivalent
Pneumatic Test Set	Model RT-200, Timeter or equivalent
Stopwatch	Digital or analog

Item	Description
Syringe	1 liter capacity, with tracheal adapter, Hamilton P/N 86302 or equivalent
Syringe	50cc
Torque Screwdriver	0 - 100 inch/ounce with 5/64" Allen Driver
DC Power Supply	0 - 6 VDC, Variable Power Supply
Variable AC Power Transformer	Variac, 0 - 140 VAC, 0 - 240 VAC
4-Way Valve	Standard I.V. 1/8" I.D. Valve 4-Way
Stop Cock	

8.2.2 Common Tools

Item	Description
Allen Hex Drivers	3/16", 3/32", 7/64", 9/64", 5/32" (Xcelite or equivalent)
Diagonal Cutter	
Hemostat	Four (4) inch or equivalent
Needle Nose Pliers	Long thin nose pliers
Screwdriver, Phillips	#2 Phillips, 6" shaft
Wrenches, Open End (2)	5/8"

8.3 VENTILATOR MAINTENANCE

The Avian Transport Ventilator is designed to provide the maximum amount of utilization with a minimum amount of maintenance. When determining the frequency of required preventive maintenance, many factors must be considered, including:

- Frequency and length of use
- Quality of the compressed air source(s)
- Environmental conditions

The Avian Transport Ventilator, like other pieces of healthcare equipment, will require routine maintenance over time. Refer to the following for recommended maintenance intervals.

8.3.1 Recommended Maintenance Schedule

INTERVAL	RECOMMENDED PROCEDURES
Once Every Month	Verification of Performance: Perform a Ventilator Performance Check as outlined in Section 4.3 on page 4-2. If the ventilator does not perform to stated specifications, remove the unit from service and refer the ventilator to technical service.
Annual Inspection	Complete the annual inspection and replacement procedures outlined below in Section 8.3.2 and the test procedure outlined in Section 4.3 on page 4-2.
Every two (2) years	A complete ventilator maintenance will be required at a minimum of every two (2) years. Complete the ventilator maintenance procedures as outlined in Section 8.3.3. on page 8-5. A complete test of the Avian as outlined in Section 8.4 on page 8-8 must be performed following any maintenance procedure that requires the case to be opened. The Avian Transport Ventilator should be repaired and/or calibrated only by an authorized Bird trained service technician or Bird Products Corporation.

8.3.2 Annual Inspection

Visually inspect the Avian Transport Ventilator for damage to the covers, knobs and controls.

8.3.2.1 Battery Inspection

NOTES:

- Refer to Figure 8.3, Battery Compartment on page 8-23 for the following instructions.
- Always complete a Performance Check upon completion of the battery installation (refer to Section 4.3 on page 4-2).

Remove the battery (P/N 68106) and inspect for cracks in the battery case and for leakage of the electrolyte by following the procedures listed below.

- Disconnect the External AC Power Source from the wall and from the Avian Transport Ventilator.
- Locate and remove the five (5) screws (item #2 on Figure 8.3) that hold the Battery Compartment Cover (item #1 on Figure 8.3) to the bottom case half.
- Carefully remove the battery from the compartment and disconnect the battery electrical connector. Inspect for damage. If any damage is noted, install a new battery.
- Reconnect the battery electrical connector. Make certain that the BLACK battery cable connector is connected to the negative [-] battery terminal and that the RED battery cable connector is connected to the [+] battery terminal.
- Replace the Battery Compartment Cover.
- Complete the Performance Check specified in Section 4.3 on page 4-2.

8.3.2.2 Battery Care

CAUTION ✔

✔ Prolonged storage at high temperatures (above 80°F - 27°C) can result in premature battery failure. Failure to recharge the battery while it is in storage will cause premature failure of the battery.

The internal battery of the Avian Transport Ventilator offers a wide operating range, simple recharge procedures and uncomplicated battery replacement. Battery life will depend on its use and maintenance.

NOTE: Batteries that do not meet the charge enable criteria (3.96 volts) within 24 hours should be replaced. This condition will be indicated by the front panel Battery Low/Fail Indicator being illuminated while external power is present (even if the front panel Mode switch is in the OFF position).

Bird Products Corporation recommends that in periods of disuse, the batteries should be charged once every two months. To recharge the battery, simply connect the AC power supply adapter or the 12 VDC power cable to the POWER INPUT jack on the ventilator and connect the AC power supply adapter or the 12 VDC power cable to the proper power source. Recharge time will typically be between 14 - 16 hours.

CAUTION ✔

✔ The correct polarity must be observed when the battery is replaced. The RED connector on the ventilator battery cable connects to the [+] battery terminal. The BLACK connector on the ventilator battery cable connects to the [-] battery terminal.

NOTE: The Avian Transport Ventilator uses a sealed lead acid battery which, in certain states and countries, must be disposed of through an authorized recycling center or disposed as hazardous material.

8.3.2.3 Bleed Muffler Replacement

Remove and replace the muffler retainer (P/N 47011) and bleed muffler (P/N 20529) [items #4 and #5 in Figure 8.3] from the bottom case.

8.3.2.4 Gas Inlet Filter Replacement

CAUTION ✔

✔ Do not remove the entire inlet filter assembly from the ventilator when replacing the filter element and O-ring. If the entire inlet filter assembly must be removed, use extreme care to prevent debris from entering the manifold.

Using two (2) 5/8" open end wrenches, separate the two (2) halves of the inlet filter assembly. Use one (1) wrench to prevent the assembly from turning in the manifold. Remove the outer portion of the assembly by turning counter clockwise (CCW). Remove and replace the nylon cone filter element (P/N 06804) and the O-ring (P/N 01943).

8.3.3 Two (2) Year Maintenance

✔ Before opening the case of the Avian Transport Ventilator, place the ventilator Mode Switch in the OFF position, remove the battery, and disconnect all external power and pneumatic connections from the unit.

✔ Always follow proper static grounding procedures when removing and replacing the printed circuit boards.

NOTE: Refer to Figure 9.2 on page 9-5 for the following disassembly/ reassembly instructions.

8.3.3.1 Disassembly

- Avian Case

Place the ventilator on a suitable work surface with the bottom of the case facing upward. Disconnect all external power and pneumatic connections to the ventilator. Remove the battery (refer to Section 8.3.2.1). Remove and replace the Bleed Muffler and Retainer Ring (refer to Section 8.3.2.3).

Locate and remove the five (5) screws (item #3 in Figure 8.3) that hold the case halves together. Carefully separate the top and bottom case halves. Disconnect the bleed tubes from the solenoid valves and the main solenoid valve exhaust line from the bottom case. Disconnect P-8 Battery Cable from J-8 of the Power Supply Printed Circuit Board. The bottom case is now free to be removed.• Power Printed Circuit Board
Locate and disconnect P-2 at J-2 of the Power Supply Printed Circuit Board. Remove one (1) screw securing the black grounding cable to the case. Remove the one screw securing the brace to the Main Printed Circuit Board. Remove the three (3) mounting screws that secure the board to the manifold assembly.

- Pneumatic Manifold Replacement

Locate and disconnect the demand solenoid (item #30) and the Main Solenoid (item #29) cables at J400 and J401 of the Main Printed Circuit Board. Locate and disconnect potentiometer cable at J246 of the Main Printed Circuit Board. Locate and disconnect the proximal pressure line (item #40) from the manifold panel (item #22). Remove the hex head screw (item #31) that secures the manifold to the case and remove the pneumatic manifold assembly from the case.

- Main Printed Circuit Board

To remove the Main PCBA, remove the membrane switch ribbon cable from J-3 of the Main Printed Circuit Board. Turn the unit over so the front panel faces upward. Remove the control panel cover by unlatching the cover and pulling it straight forward from the hinges. Remove the control knobs (6 pcs., item #20 on Figure 9.3.1). Continue by removing all of the control knobs except the Pressure Relief and Flow Control knobs. Again, turn the unit over so the front panel is facing downward. Locate and remove the screws that secure the circuit board assembly to the case. Carefully lift the circuit boards (Main and Display PCB assemblies) from the case.

- Front Panel Overlay and Switch Panel Replacement

Remove the old overlay and switch panel (item #18 on Figure 9.3.1) by lifting one of its corners with a small, thin-bladed common screwdriver and pulling it away from the case. When the overlay and switch panel have been peeled away from the case, remove them by pulling the ribbon cable and connector out of the case.

NOTE: Use care to properly align the new overlay assembly during the installation process. Once the overlay is applied to the cover, it cannot be removed without damaging the overlay assembly.

With the new overlay/switch panel assembly (item #18 on Figure 9.3.1), insert the ribbon cable and connector into the slot in the case. Peel the protective cover from the back of the new overlay assembly. Align the new overlay assembly and apply it to the case.

8.3.3.2 Reassembly

- Main and Display PCB

Position the boards in the case and secure the assembly with the mounting screws. Reinstall the knobs and control panel cover.

- Manifold Assembly

Replace the previously removed pneumatic manifold assembly with a new manifold assembly P/N 15484.

To reassemble, position the pneumatic manifold assembly in the case and install the hex head screw to secure the pneumatic manifold to the case. Locate and reconnect the demand solenoid (item #30) and the Main Solenoid (item #29) cables at J400 and J401 of the Main Printed Circuit Board. Locate and reconnect potentiometer cable at J246 of the Main Printed Circuit Board. Locate and reconnect the proximal pressure line (item #40) from the manifold panel (item #22).

- Power Printed Circuit Board

To reinstall, attach the Power Supply Printed Circuit Board to the manifold assembly with the three (3) mounting screws. Reconnect cable P-2 to J-2 of the Power Supply Printed Circuit Board. Reinstall the one (1) screw that secures the black grounding cable to the case and the one screw securing the brace to the Main Printed Circuit Board.

Reconnect P-8 Battery Cable to J-8 of the Power Supply Printed Circuit Board. Reconnect the bleed tube(s) from the solenoid valves to the outlet port on the inside of the bottom case. Reconnect the tube from the main solenoid valve exhaust line to the outlet port on the inside of the bottom case.

The bottom case is now ready to be reattached. Carefully align and reattach the bottom case to the top case. Secure the two halves together with the five (5) screws (item #3 in Figure 8.3) that hold the case halves together.

Complete the performance check outlined below in Section 8.4: Test Procedures. Units that fail to pass the performance check should be repaired and/or calibrated as needed to pass the test. Refer to the Section 8.5: Technical Troubleshooting Chart on page 8-17 or Section 8.6: Pressure Transducer Calibration procedure on page 8-20 to make the necessary repairs.

8.4 TEST PROCEDURES

CAUTION ✔

✔ The calibration accuracy of all test equipment used to test and calibrate the Avian Transport Ventialtor should be verified before recalibrating the ventilator.

NOTE: The assumption is made that all service technicians are familiar with the operation of the test equipment that is specified in this section. References will be made to the test equipment but test equipment operating instructions are not included in the test procedures. Please refer to the individual test equipment manufacturer's operating manuals for specific instructions.

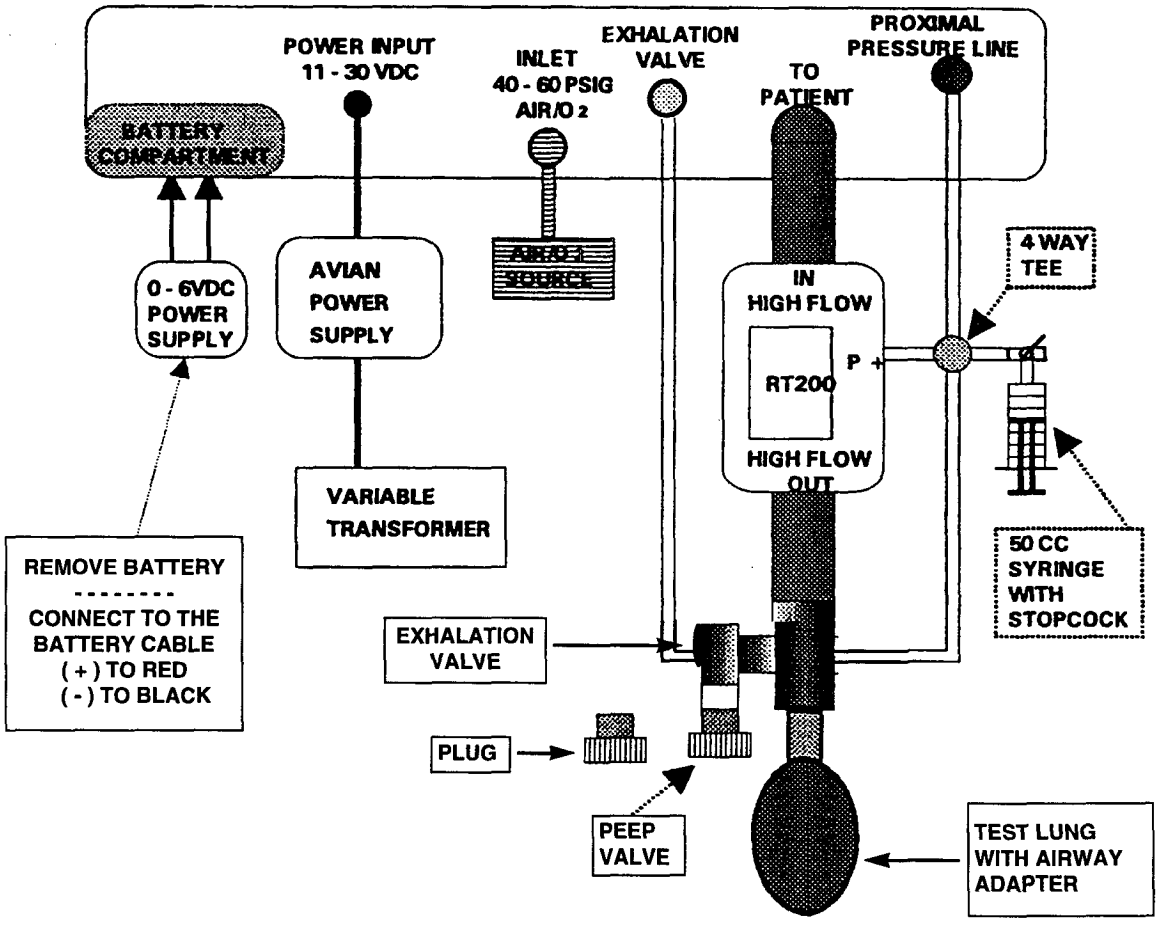
The calibration procedures for the Avian Transport Ventilator are software driven. There are no calibration curves to plot or potentiometers to adjust. The calibration data is stored in the EPROM.

8.4.1 Avian Test Settings

NOTE: These are the control and alarm settings to be used for the test and calibration procedures, unless there are specific instructions to change the settings.

Figure 8.1 STANDARD TEST DIAGRAM

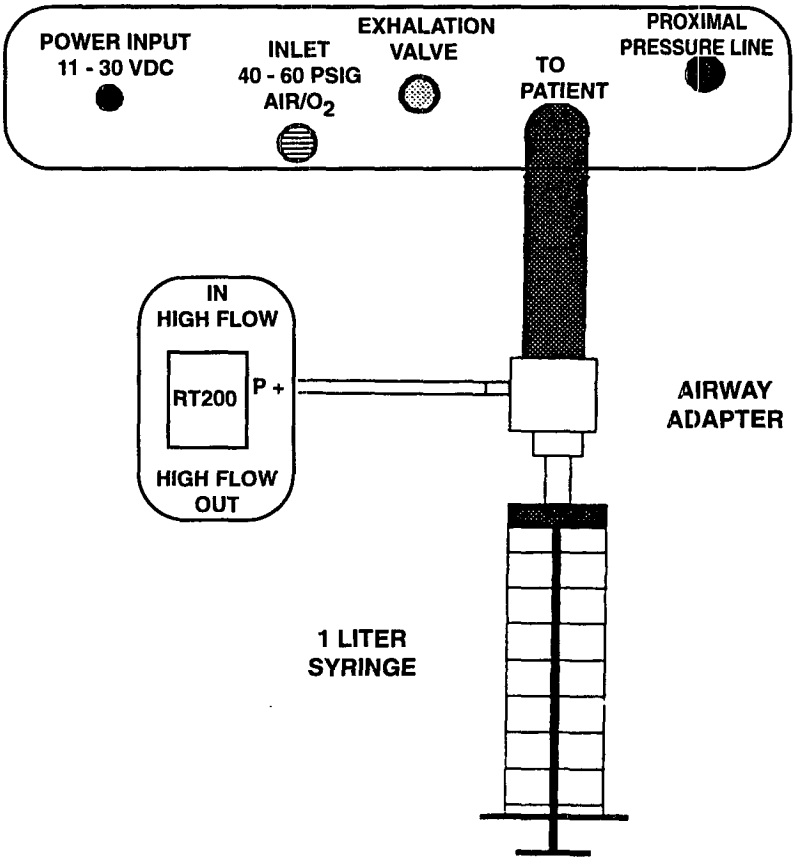
AVIAN ELECTRICAL/PNEUMATIC CONNECTIONS



ALARM AND CONTROL SETTINGS	
Assist Sensitivity	-4 cmH_2O
Breath Rate	12 bpm
Over Pressure	Maximum
Inspiratory Time	0.5 Second
Flow	60 lpm
High Pressure Alarm	5 cmH_2O Above PIP
Low Pressure Alarm	10 cmH_2O Below PIP
Mode	SIMV

Figure 8.2 ANTI-SUFFOCATION VALVE TEST DIAGRAM

AVIAN ELECTRICAL/PNEUMATIC CONNECTIONS



8.4.2 Testing

NOTE: Whenever the (*) appears in the Figure Number column of the following table, the technician will be required to change the standard test configuration. Please read the test procedure before performing the test.

TEST	FIG. #	PROCEDURE
Internal Self Test	8.1(*)	With the MODE switch in the OFF position, disconnect the tube that is connected to the PROXIMAL PRESSURE LINE port on the Avian. Turn the MODE switch to the SIMV position and the ventilator will automatically perform a series of internal checks. Verify the following: • Audible Alarm Sounds • All LED Indicators ON • All LED Indicators OFF • Current Settings (displayed on monitor) for: Rate, Tidal Volume, High and Low Pressure Alarms and Flow • Audible Alarm Ceases Reconnect proximal pressure line audible alarm ceases.
Alarm Silence/Reset	8.1	This function is tested several times as part of the test in this performance check. Verify that the alarm does silence or reset as stated in the test procedures.
Apnea Alarm	8.1	Set BREATH RATE control to 1 bpm. After a 20-second interval the Apnea Alarm will activate the audible and visual alarms and the ventilator will deliver controlled breaths at a rate of 12 bpm. Press the ALARM/ RESET button to clear the alarm. Reset the BREATH RATE control to 12 bpm and resume testing.
Breath Rate	8.1	Select the breath rate mode on the pneumatic test set. Depress the Breath Rate Display switch on the ventilator to display the breath rate on the monitor display and compare it to the pneumatic test set breath rate. Verify that the breath rates match to ±1 bpm.

TEST	FIG. #	PROCEDURE
Disconnect and Low Peak Pressure Alarms	8.1	Disconnect the Test Lung from the exhalation valve. Verify that the Disconnect and Low Pressure audible and visual alarm(s) activate. Reconnect the test lung to the exhalation valve to cancel the alarms.
Self CAL/Display Test Mode	8.1 (*)	Place the MODE SWITCH in the OFF position. Disconnect the Proximal Pressure line at the Exhalation Valve. Place the mode switch in the CAL position. The ventilator will monitor the airway pressure transducer output for a maximum of 3 seconds. If the measured reading is within ±4 cmH_2O of zero, the unit will display PASS on the monitor display. Verify the following Indicators are illuminated: • PEEP Not Set • Apnea • Battery Low/Fail • External Power Fail • Disconnect • Power • External Power (if connected) • All Airway Pressure Bar Graph Segments Verify that all LED indicators that are associated with switches illuminate when the switch is pressed. Verify that control values are displayed on the monitor display when the function switch associated with the control is pressed and that all control potentiometers will rotate through their full range. Place the MODE SWITCH in the OFF position. Clamp off the end of the Proximal Pressure line that was disconnected at the Exhalation Valve with hemostats.

TEST	FIG. #	PROCEDURE
Self CAL/Display Test Mode (cont.)	8.1 (*)	Open Stopcock and apply a pressure to the line (as read on the pneumatic test set) with the 50cc syringe that is greater than ±4 cmH_2O. Place the MODE SWITCH in the CAL position. The ventilator will sound an audible alarm and flash FAIL in the monitor display. (The unit will not store this value). Place the MODE SWITCH in the OFF position and turn the Stopcock to the OFF position. Reconnect the Proximal Pressure Line to the Exhalation Valve.
Flow	8.1	Disconnect the Test Lung and set the Mode selection switch to SIMV and the Inspiratory Time to 1.0 second. Verify that a flow of 60 lpm ±6 lpm is displayed on the pneumatic test set. Repeat the test for flows of 10 lpm ±2 lpm and 100 lpm ±10 lpm. Return Flow to 60 lpm.
High Peak Pressure Alarm	8.1	Lower the High Pressure Alarm setting to 5 cmH_2O below the PIP reading. Verify that the High Peak Pressure audible/visual alarms activate. Inspiration will be terminated and the ventilator will cycle to exhalation. Reset the High Peak Pressure Alarm and depress the Alarm Silence/Reset button and verify the alarm indications are cleared. Continue with the test procedure.
I:E Ratio Alarm	8.1	Adjust the Inspiratory Time control to the maximum setting of 3.0 seconds. Verify that the audible and visual I:E Ratio alarms activate immediately. Reset the Inspiratory Time control to 0.5 seconds to cancel the alarm condition.

TEST	FIG. #	PROCEDURE
Demand Flow/ Assist Sensitivity	8.1	Remove the PEEP valve and open the Stop-cock on the 50cc syringe. Disconnect the Proximal Pressure line at the Exhalation Valve and clamp off the end of the line. • Set Mode to SIMV. • Set Breath Rate Control to minimum (full CCW). • Press PAW and display airway pressure. • Set the pneumatic test set to read flow. Pull (retract) the plunger on the 50cc syringe to generate a pressure of -5 cmH_2O as read on the Avian Transport Ventilator display. Verify a flow of 60 lpm ±6 lpm is displayed on the pneumatic test set. Flow time is at 3 seconds. Reconfigure to the Standard Test Configuration in Figure 8.1 on page 8-9.
Inspiratory Time	8.1	Set the pneumatic test set to display inspiratory time. Press the INSP. TIME display button on the Avian Transport Ventilator and verify the setting that is displayed on the ventilator compares to that of the pneumatic test set display.
Leak Check	8.1 (*)	*NOTE:* Make sure the breathing circuit is tight before starting this test. Small leaks in the circuit will cause the test to fail. Set the display on the Avian Transport Ventilator to read PAW and the Breath Rate to minimum (full CCW). Remove the PEEP valve and install a plug in the outlet port of the Exhalation Valve. Press the Manual Breath switch to deliver a manual breath. Wait 3-5 seconds and record the airway pressure. Wait an additional 15 seconds and record the airway pressure again. Subtract this reading from the previous reading. The difference should be < 5 cmH_2O. Reconnect to the Standard Test Configuration in Figure 8.1 on page 8-9.

TEST	FIG. #	PROCEDURE
Power Indicator	8.1	This is a green LED that will light whenever the MODE switch is any position other than OFF.
Sigh Breath	8.1	Set the Tidal Volume to 500 ml and activate the Sigh function. Verify the next breath tidal volume is 750 ml ±75 ml as measured on the pneumatic test set. Restore to the Standard Test Configuration in Figure 8.1 on page 8-9.
Over Pressure Relief	8.1	Set the display to Paw and the following controls: • Pressure Relief – Full CCW (Minimum) • Breath Rate – Minimum (full CCW) • Tidal Volume – 2000 • Flow – 60 lpm Press the Manual Breath button and verify the airway pressure is limited to <10 cmH_2O. Set the Pressure Relief to maximum (full clockwise). Press the Manual Breath button and verify the airway pressure is limited to 100 cmH_2O ±15 cmH_2O.
PEEP Not Set Alarm	8.1	Set the ventilator to display PAW and the following controls: • Man. PEEP Ref. – Zero (0) • Assist/Sensitivity – -8 cmH_2O Adjust the PEEP Valve at the Exhalation Valve to 5 cmH_2O as observed on the Avian Transport Ventilator display. Verify that the PEEP Not Set audible and visual alarms activate. Adjust the Man. PEEP Ref. control to 5 cmH_2O and verify that the audible alarm resets. Press the Alarm Silence/Reset to reset the visual indicator. Restore the test setup to the Standard Test Configuration in Figure 8.1 on page 8-9.

TEST	FIG. #	PROCEDURE
Pressure Transducer	8.1	Set the Avian Transport Ventilator to display Paw and disconnect the 3/16" Proximal Pressure Line at the Exhalation Valve. Verify the display reads 0 ±1 cmH_2O. Clamp off the disconnected end of the proximal pressure line. Open the stopcock on the 50cc syringe to the proximal pressure line and press in the plunger to apply 100 cmH_2O on the ventilator display. Verify the pneumatic test set reads 100 cmH_2O ±5 cmH_2O. Restore to the Standard Test Configuration in Figure 8.1 on Page 8-9.
Battery Low/Fail Manual Breath	8.1	Disconnect the Avian Transport Ventilator External Power Supply from the ventilator. Reduce the voltage on the 0 - 6 VDC Power Supply to 5.6 VDC. The Battery Low/Fail will flash and an audible alarm will sound. Press the Silence/Reset switch and the audible alarm will silence. The Battery Low/Fail light will continue to flash. Press the Manual Breath and verify that the ventilator will deliver a manual breath. Reduce the voltage to 5.1 VDC. The audible alarm sounds and the Vent Inoperative visual indicator illuminates. Press the Silence/Reset switch and verify that the audible and visual alarms remain on. Increase the voltage to 6.0 VDC. The audible alarm will silence. The Vent Inoperative visual indicator will remain on until the Silence/Reset switch is pressed.

TEST	FIG. #	PROCEDURE
External Power Low/Fail Alarm	8.1	Connect the Avian Transport Ventilator External Power Supply and disconnect the battery test connector. Set the External Power Supply voltage to 11 VDC and verify that the External Power indicator is illuminated. Gradually reduce the External Power Supply voltage to 10 VDC and verify that the External Power Fail indicator illuminates. Return the voltage to 11 volts.
Anti-Suffocation Valve	8.2	Turn the Avian Transport Ventilator OFF. Connect the 1 L. syringe (with the plunger pressed all the way in) as illustrated in Figure 8.2 on page 8-10. Pull on the syringe plunger to withdraw 1 liter of air in approximately 2 seconds. Verify that the pressure displayed on the pneumatic test set does not go below -4 cmH_2O.

8.5 TECHNICAL TROUBLESHOOTING GUIDE

NOTES:

- The Technical Troubleshooting Guide is available for trained service personnel. Untrained personnel should limit their repairs to the steps outlined in the Clinical Troubleshooting Chart in Section 5.2 on page 5-1.
- A performance test should be completed before proceeding with repairs. The technical performance test in Section 8.4 will enable the technician to validate the complaint and to observe the symptoms.
- Good troubleshooting protocol is to always check all connectors and cabling before making any tests and/or adjustments.

Symptom	Possible Cause	Corrective Action
Airway Pressure Monitor Inoperative	Display PCBA Main PCBA	Replace the defective sub-assembly.
APNEA Alarm	Main PCBA	Replace the defective sub-assembly.
Auto Cycling of the Ventilator	Pneumatic Manifold Assembly Main PCBA Leak in Circuit Manual PEEP Reference set inappropriately	Replace the defective sub-assembly. Check for leaks. Set control at an appropriate level.
Battery Low/Fail Alarm - Audible and visual alarm	Battery Power Supply PCBA Main PCBA	Replace the defective sub-assembly.
Battery Low/Fail Alarm - Visual alarm	Battery is below acceptable charging voltage or the battery has a shorted cell.	Replace the battery.
CAL visual is flashing on the display and an audible alarm is present.	The airway pressure transducer is out of calibration.	Calibrate the airway pressure transducer in the **CAL** mode.
Disconnect Alarm	Exhalation Valve Flow Solenoid Valve Demand Solenoid Valve Pressure Regulator Pneumatic Manifold Assembly Main PCBA	Replace the defective sub-assembly.
Error Code is displayed on the monitor display.	Main PCBA	Replace the defective sub-assembly.
FAIL visual is flashing on the display with an audible alarm present.	The patient circuit was not disconnected during the initial power on self test.	Disconnect the patient circuit and momentarily turn the **Mode Control** switch to the **OFF** position.
External Power Fail Alarm	No power to the external power adapter. External power adapter's line selector switch set to the wrong voltage. External AC Power Source External Power Connector sensor on the Avian Blown Fuse on Power Supply Power Supply PCBA Main PCBA	Restore the external power. Set the line selector switch to the proper line voltage. (115 or 230 VAC). Replace the defective sub-assembly.

Symptom	Possible Cause	Corrective Action
High Peak Pressure Alarm	Change in ventilation parameters. Obstructed or kinked exhalation drive line. Exhalation Valve PEEP Valve Flow Solenoid Valve Pneumatic Manifold Assembly Main PCBA	Readjust the alarm setting. Check and clear the exhalation line. Replace the defective sub-assembly.
I:E Ratio Alarm	Inspiratory time is set to greater than 50% of breath period. Breath Rate is set too high to allow 50% of period for the exhalation phase Main PCBA	Readjust the Inspiratory Time or the Breath Rate. Replace the Main PCBA.
LED(s) Inoperative	Display PCBA Main PCBA	Replace the defective sub-assembly.
Low Flow - Low Volume	External Air/O2 Supply The flow control system is out of calibration.	Increase the external Air/O2 Supply pressure. Recalibrate flow control system.
Low Peak Pressure Alarm	Alarm set too high. Leaks or disconnect in the patient circuit and/or humidifier. Exhalation Valve Flow Solenoid Valve Pressure Regulator Pneumatic Manifold Assembly Main PCBA	Readjust the alarm setting. Check for leaks and/or disconnects. Replace the defective sub-assembly.
Membrane Switch(s) Inoperative	Membrane Switch Assembly Main PCBA	Replace the defective sub-assembly.
Mode Switch Inoperative	Main PCBA	Replace the defective sub-assembly.

Symptom	Possible Cause	Corrective Action
Monitor LED Display Segment(s) Inoperative	Display PCBA Main PCBA	Replace the defective sub-assembly.
PEEP Not Set Alarm	Main PCBA Demand Solenoid Valve Pneumatic Manifold Assembly	Replace the defective sub-assembly.
Pressure Relief Valve Inoperative	Pneumatic Manifold Assembly	Replace the defective sub-assembly.
Transducer Calibration Failure	Main PCBA	Replace the defective sub-assembly.
Vent Inoperative Alarm	Main PCBA Power Supply PCBA	Replace the defective sub-assembly.
Ventilator will not power up from the internal battery. No lights visible or audible alarms present.	The battery is discharged below the acceptable level.	Recharge or replace the battery.

8.6 PRESSURE TRANSDUCER CALIBRATION

CAUTION ✔

✔ The calibration accuracy of all test equipment used to test and calibrate the Avian Transport Ventilator should be verified before recalibrating the ventilator.

Disassemble the case as described in Section 8.3.3.1. Locate the DIP switches SW503-2 (shown as SW503 in Figure 9.3, Main Printed Circuit Board Illustration) and place them in the ON position. Reconnect external or battery power to the ventilator. Connect a 40-60 psig medical grade air/O_2 source to the ventilator and turn the Mode switch to the Control setting. At this point, the monitor will display "E_xx" and the P_{aw} indicator will begin flashing. The "E" indicates the last error code that may have caused a Vent Inop ("0" indicates none), and "xx" indicates the actual error code. Depress the P_{aw} switch. The monitor display will blank and the P_{aw} and Flow indicators will flash. The operator now has the option of calibrating either the Flow control valve or the pressure transducer.

To calibrate the Flow control valve, depress the Flow switch once and adjust the Flow control to full counterclockwise position. The monitor display will alternately flash "FCAL" and "5". Depressing the Flow switch a second time calibrates the Flow control valve.

To calibrate the pressure transducer, depress the Flow switch a third time, then depress the P_{aw} switch twice. The monitor will display "PCAL" and "0". Disconnect the airway pressure line and depress the P_{aw} switch a third time. The monitor display will alternately flash "PCAL" and "50". With a calibrated pressure source, apply 50 cmH_2O of pressure to the airway pressure input (item #5 in Figure 3.2 on page 3-16). Depress the P_{aw} switch again to set the pressure transducer span. The monitor display will then show the acutal pressure input, and the transducer is now calibrated. Turn the Mode switch to OFF and press the Alarm Silence/Reset button. Locate the SW503-1 and SW503-2 DIP switches and return them to the OFF position. Complete a performance check of the ventilator (refer to Section 4.3 on page 4-2) before reassembling the unit. Perform calibration procedures again if the Avian Transport Ventilator does not pass the performance check.

Disconnect the pneumatic and power sources from the ventilator and reassemble the unit following instructions in Section 8.3.3.2.

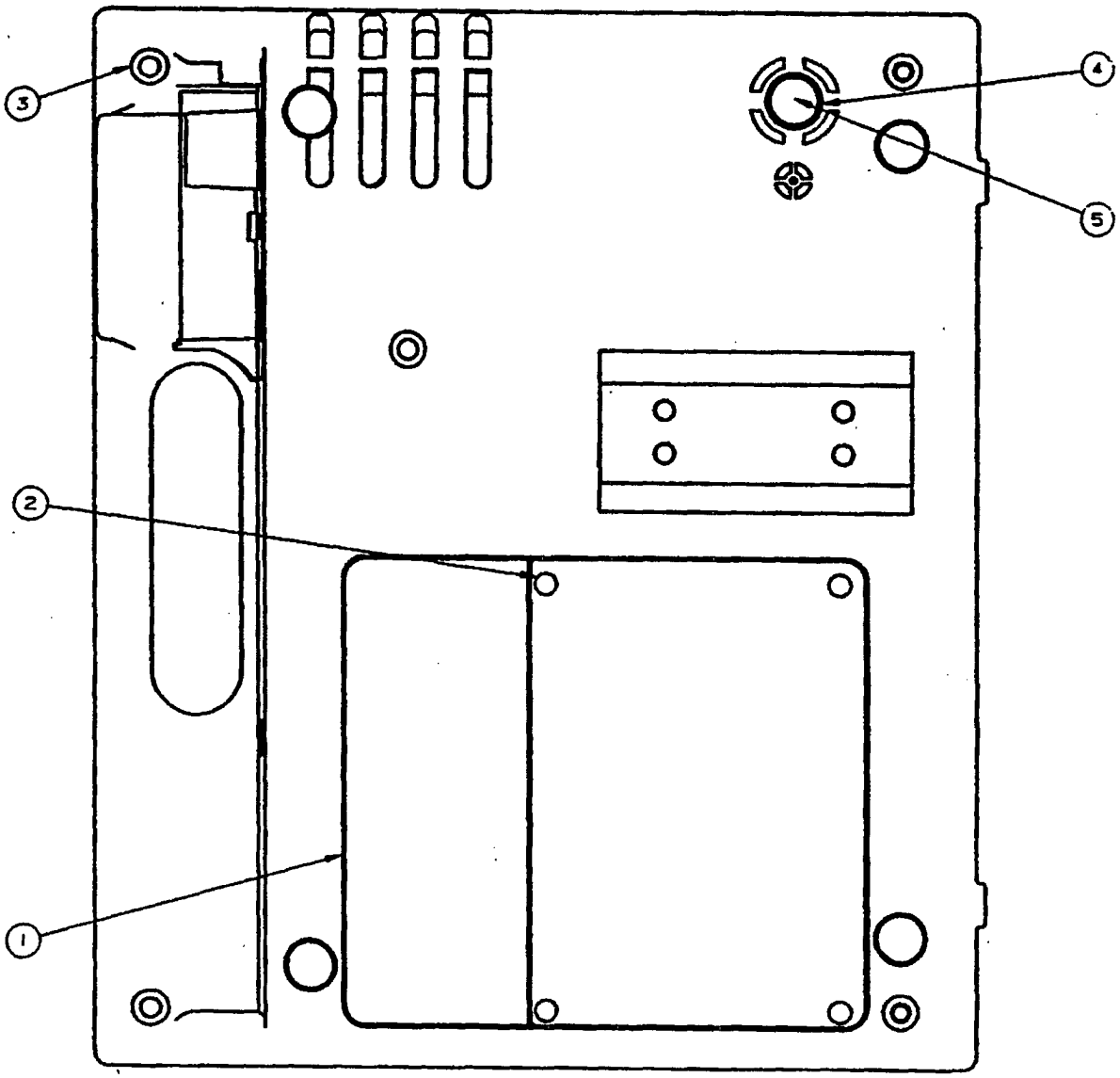
8.7 ERROR CODES

The Avian Transport Ventilator will display error codes when certain failures occur. While these codes are intended to facilitate board level repairs, the codes are provided as reference information.

Error Code	Meaning
3	The PAL is in reset.
4	The PAL has detected a single error.
5	The PAL has detected a double error.
10	Pass 1, Bit B of Byte SP is set when it should not be.
11	Pass 1, the read/verify failed at Byte R0
12	Pass 1, Byte B of Byte @SP is at 0 when it should not be.

Error Code	Meaning
13	Pass 1, read/verify failed at Byte R0.
20	The Mode Switch has more than one switch closed.
21	The Assist Switch has more than on switch closed.
30	The A to D count is 255 indicating a potentiometer overrange.
31	The 2.5 volt system reference is out of range.
32	The internal A to D reference is out of range.
40	EPROM checksum failed at power up.
41	EPROM checksum failed during run time.
50	The 4ms software watchdog failed.
51	There is a software branch to address 0202H
60	An error occurred at power up when reading the Factory Cal Zero from the EPROM.
61	An error occurred at power up when reading the Factory Cal Span from the EPROM.
62	An error occurred at power up when reading the User Cal Zero from the EPROM.
63	An error occurred at power up when reading the Factory Cal Flow from the EPROM.
70	An error occurred in writing the EPROM non-volatile RAM.

Figure 8.3 BATTERY COMPARTMENT ILLUSTRATION



Item #	Description
1	Battery Compartment
2	Battery Cover Screw (6-32 X .250, 4 locations)
3	Avian Case Screw (10-32 X .375, 5 locations)
4	Bleed Muffler Retainer
5	Bleed Muffler

AVIAN TRANSPORT VENTILATOR

SECTION 9.0: SCHEMATICS AND ILLUSTRATED PARTS

9.1 INTRODUCTION

Included in this section are the following schematics, drawings, illustrations and lists:

- Figure 9.1 – Accessories Illustration
- Table 9.1 – Accessories Replacement Parts List

- Figure 9.2 – Illustrated Parts Drawing (Exploded View)
- Table 9.2 – Illustrated Replacement Parts List

- Figure 9.3 – Main Printed Circuit Board Illustration
  - Figures 9.3.1 - 9.3.6 – Main Printed Circuit Board Schematics

- Figure 9.4 – Display Printed Circuit Board Illustration
  - Figure 9.4.1 – Display Printed Circuit Board Schematic

- Figure 9.5 – Power Supply Printed Circuit Board Illustration
  - Figure 9.5.1 – Power Supply Printed Circuit Board Schematic

- Figure 9.6 – Manifold Assembly (Sectional View)

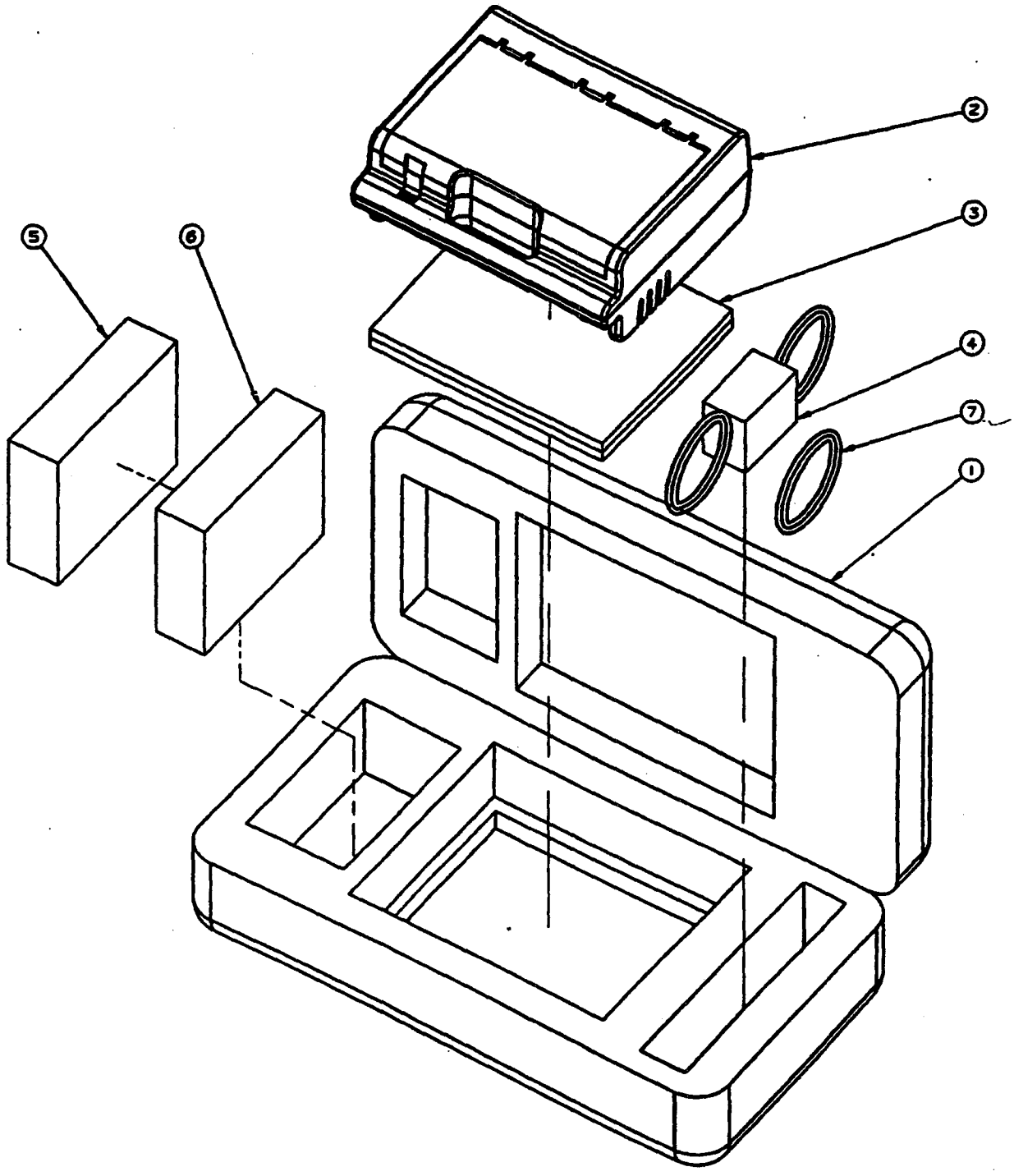
For ordering information on parts and accessories, please contact Bird Products Corporation Customer Service Department, 1100 Bird Center Drive, Palm Springs, CA 92262, (800) 328-4139 or (619) 778-7200, Fax (619) 778-7274.

SECTION 9.0: SCHEMATICS AND ILLUSTRATED PARTS

Table 9.1 ACCESSORIES REPLACEMENT PARTS LIST

Item #	Description	Part #
1	Case, Carrying	10290
2	Avian Transport Ventilator	15365
3	Manual, Instruction/Service	L1248
4	Power Supply, Avian Transport Ventilator	68107
5	Kit, Patient Circuit	10333
6	Hose Assembly O2	10293
7	Cord, DC Input, 6 Ft. Long	15364
Not Shown	Power Cord, P7, 115V	9184

Figure 9.1 ACCESSORIES ILLUSTRATION



SECTION 9.0: SCHEMATICS AND ILLUSTRATED PARTS

Table 9.2 ILLUSTRATED PARTS LIST

Item	Description	Part #
1	Screw, 6-32 X .250 (4 ea.)	04381
2	Label, Instruction	80113
3	Cover, Battery	20526
4	Gasket, EMI/O-Strip	33685
5	Battery, Rechargeable, 6V, 4.0 Ampere Hour	68106
6	Bumper, .50 Diameter x .14 High	33688
7	Case, Base (bottom half of case)	20496
8	Label, Battery Instructions	80109
9	Screw, 6-32 X 1.312 (1 ea.)	40088
10	Printed Circuit Board, Main	50370A
11	Screw, 6-32 X .50 (4 ea.)	08434
12	Printed Circuit Board, Display	50380A
*13	Case, Lid (top half of case)	20497
14	Screw, Machine, 6-32 X .25 (7 ea.)	40085
15	Plate, Latch	20518
16	Spring, .110ID X .20 X .30L	03286
17	Latch	20519
18	Overlay, Avian English	80136
*19	Switch Panel, Avian	80125
20	Knob, Control (s)	20238
21	Case, Cover (control panel cover)	20498
22	Panel, Manifold, Avian	20499
23	Printed Circuit Board, Power Supply	50390A
24	Gas Inlet Filter Assembly (includes items #24A,24B, 24C, & 24D)	10369
24A	Base, Inlet Filter	20790
24B	Filter, Nylon Cone	06804
24C	O-Ring, .426 X .070	01943
24D	Body, Inlet Filter	20791
26	O-Ring, .239 X .070	05307D
27	O-Ring, .739 X .070	05327D
28	Pneumatic Manifold Assembly (includes items # 14 (3 ea.), 22, 26, 27, 29, 30, 33, & 34	15301
29	Solenoid Assembly, Flow Valve	15303
30	Solenoid Assembly, Demand Valve	15309
31	Screw, 10-32 X 2.25 Hex Cap (1 ea.)	03826
33	Screw, 6-32 X 2.0 (4 ea.)	40084
34	Regulator, Pressure	33682
35	Screw, Machine, 10-32 X .375 (5 ea.)	40082
36	Muffler, Bleed	20529
37	Ring, Retaining	47011
38	Cable Assembly, Power Supply	15292
39	Connector, 1/8' Tube Tee	00358D
40	Tube, 1/8 ID Silicon (Proximal Pressure Line)	04029X
41	Tube, 1/8 ID Silicon (Solenoid Valve Bleed Lines)	04029X
42	Cable Assembly, Battery	15293

* When you order an Upper Case Replacement Kit, use P/N 10463. This includes item 13 & 19. You will also need to order the overlay for the appropriate language.

Figure 9.2 ILLUSTRATED PARTS DRAWING (EXPLODED VIEW)

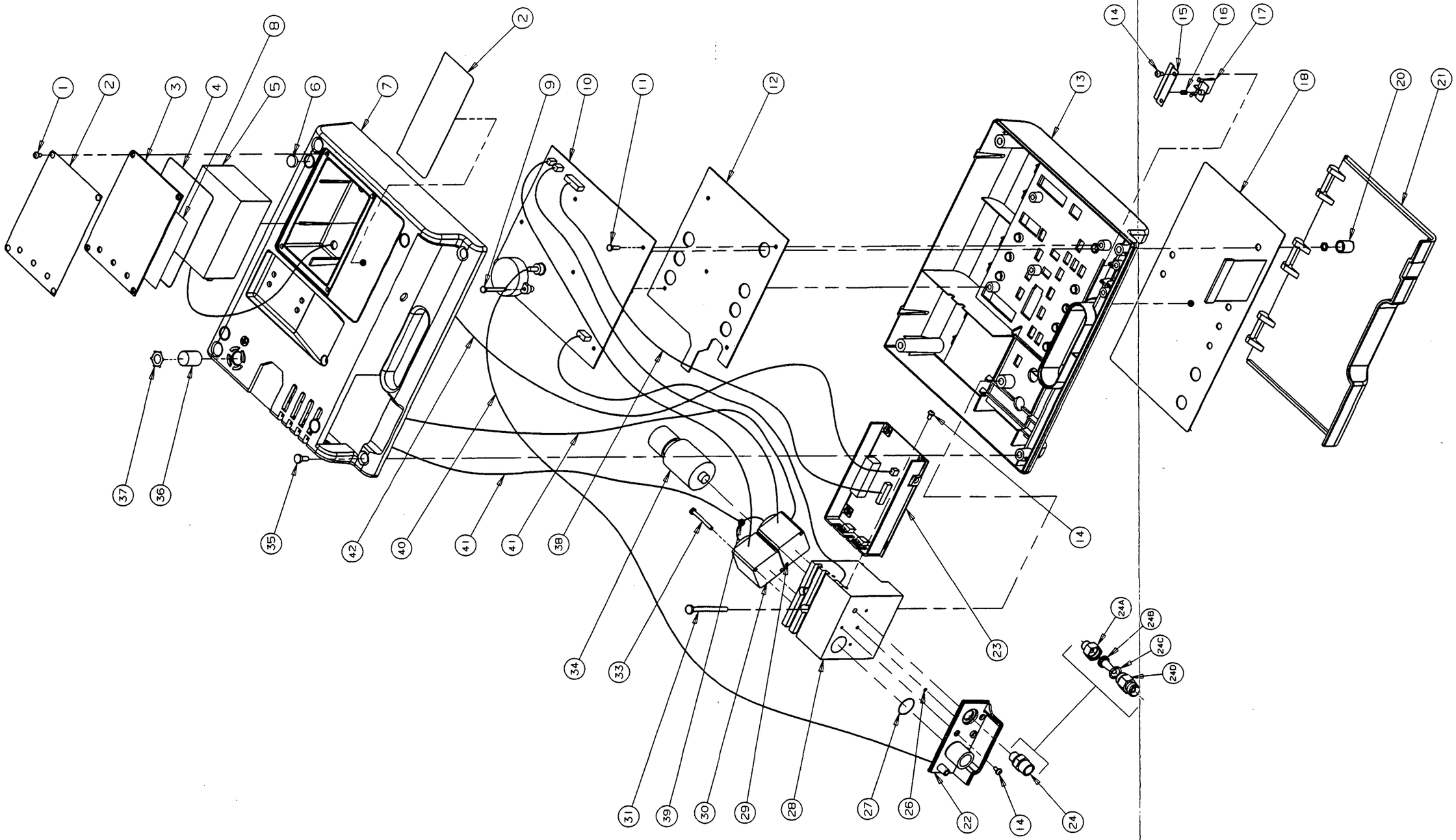


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Figure 9.3 MAIN PRINTED CIRCUIT BOARD ILLUSTRATION (P/N 50370)

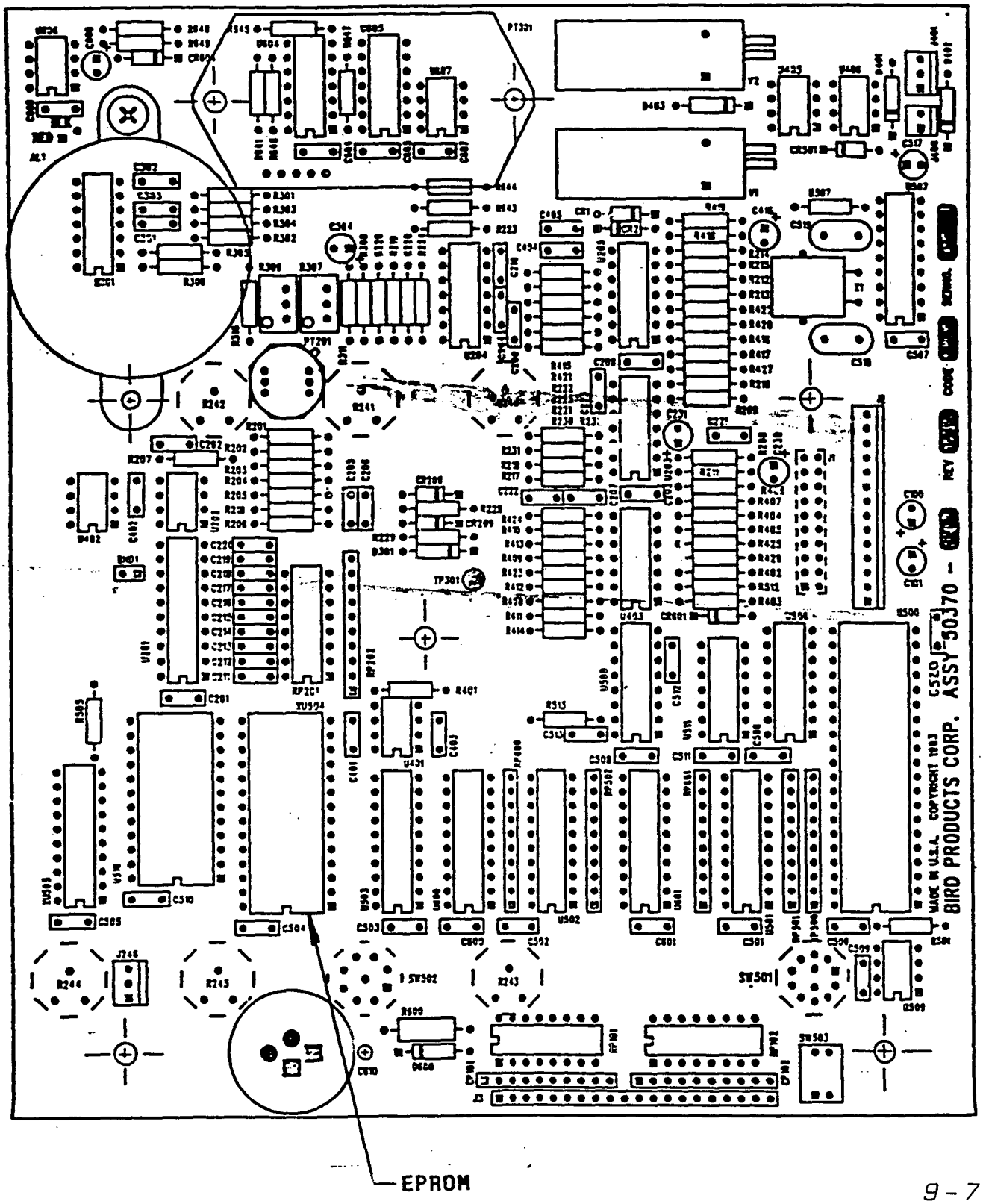

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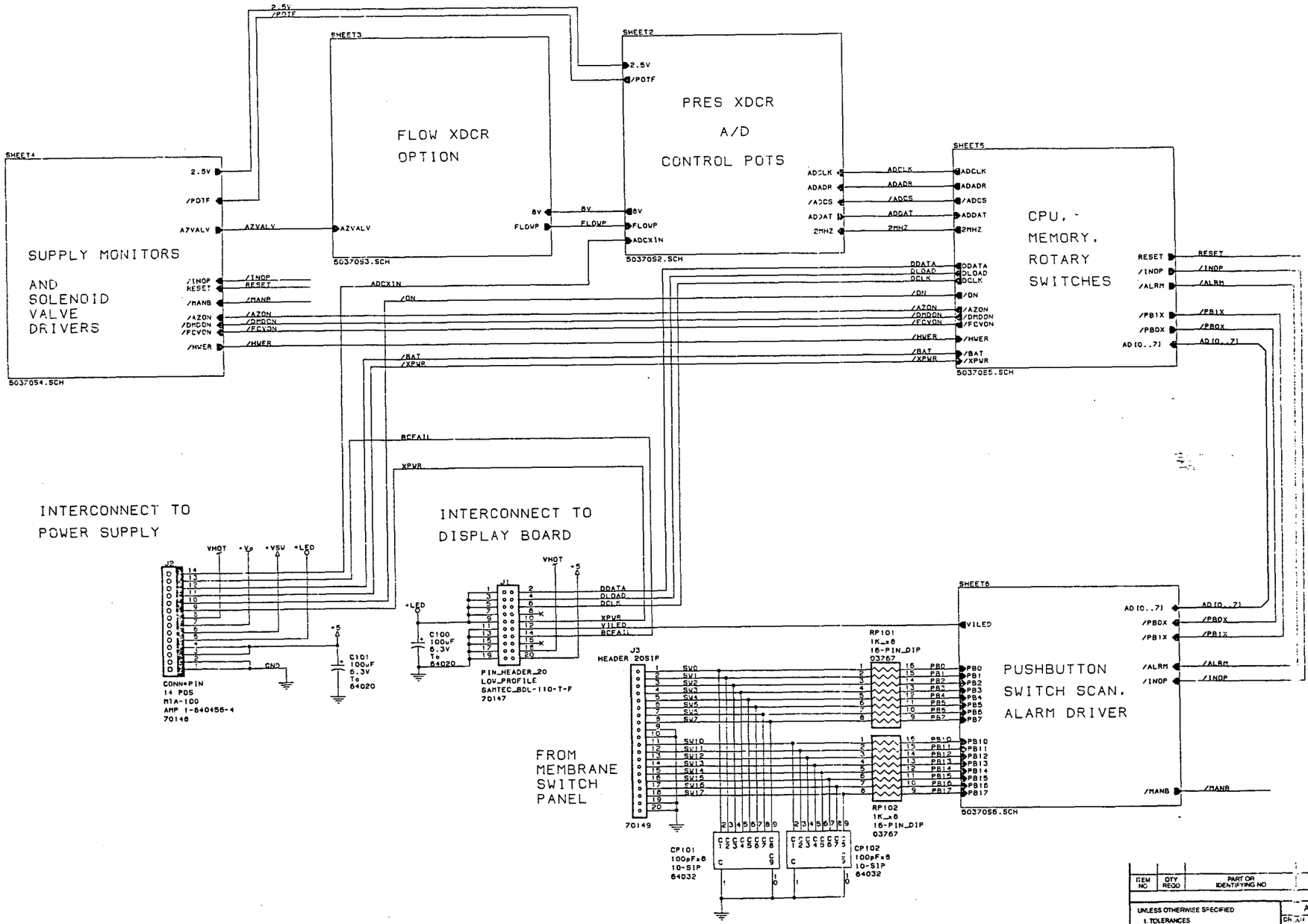
Figure 9.3.1 MAIN PRINTED CIRCUIT BOARD SCHEMATIC, SHEET 1 OF 6

REVISIONS				
SYM	DESCRIPTION	DRFTG	APPROVED	DATE
XXX	PROTOTYPE RELEASE	JKD	DD	12.7.92
A	PROD REL PER ECO# 51174	JKD	DD	3/3/93
B	REVISED PER ECO # 51452	JKD	MA	6.29.93

NOTE: UNLESS OTHERWISE SPECIFIED:

1. REVISION STATUS CHANGES TO THIS DRAWING MUST BE REFLECTED ON DRAWING 50370E.



ITEM NO	QTY REQD	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION

MATERIAL LIST

UNLESS OTHERWISE SPECIFIED
1. TOLERANCES
X ±.1 XXX ±.005
XX ±.01 ANG ±1°00'
2. MACH SURFACES ✓ OR BETTER
3. CORNER FILLETS .R ADII .005-.010
4. BREAK ALL SHARP EDGES BY 45°
5. CHAMFER FIRST & LAST THREADS 45°
6. CONC TOLERANCE .005 F.I.M.
7. INTERPRET PER ANSI Y14
8. DIMENSIONS ARE IN INCHES

APPROVALS		DATE
DRAWN		12.7.92
CHECKED	L. MAYER	12.7.92
APPROVED	D. DAVIES	12.7.92
QUALITY	L. ZIMMERMAN	6.29.93
MFG		
FINISH		

TITLE: SCHEMATIC, 1000PV MAIN

D | DWG NO. 50372 | REV B

SCALE NONE | DO NOT SCALE DRAWING | SHEET 1 OF 6

CRITICAL	☐ COMPONENT	☐ DEVICE	☐ N/A
TRACEABLE	☐ SERIAL NO.	☐ LOT NO.	☐ N/A

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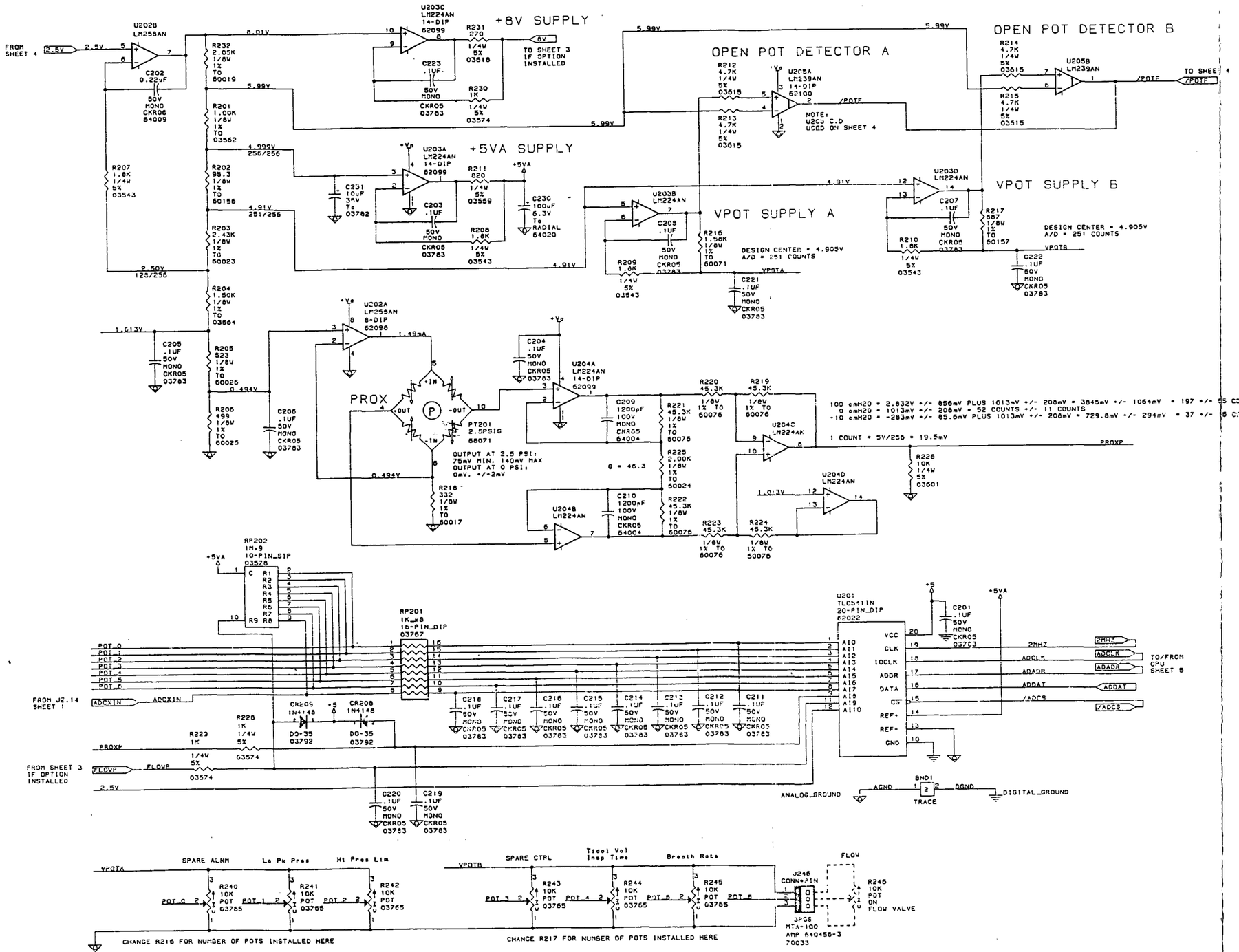
Figure 9.3.2 MAIN PRINTED CIRCUIT BOARD SCHEMATIC, SHEET 2 OF 6



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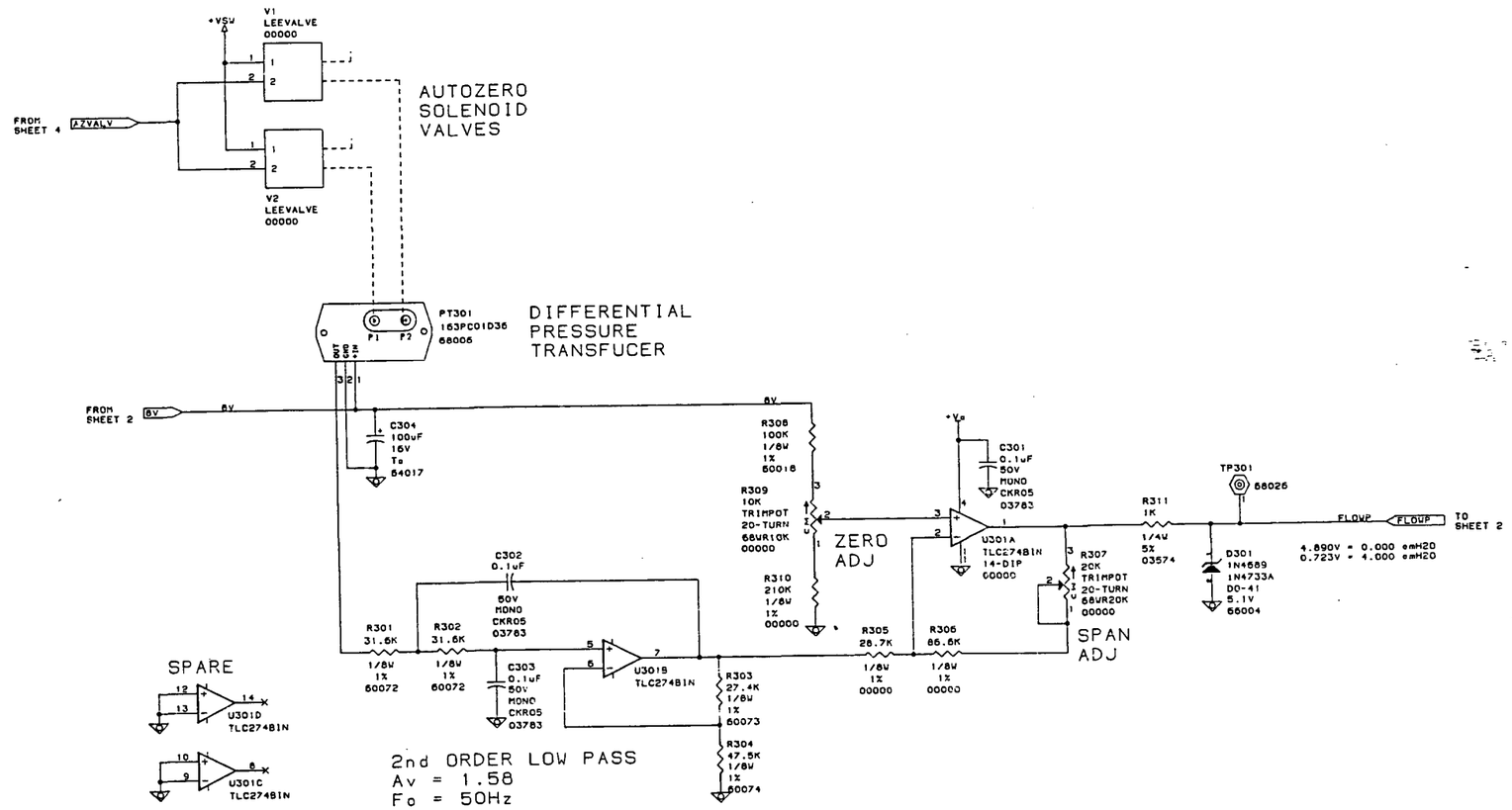

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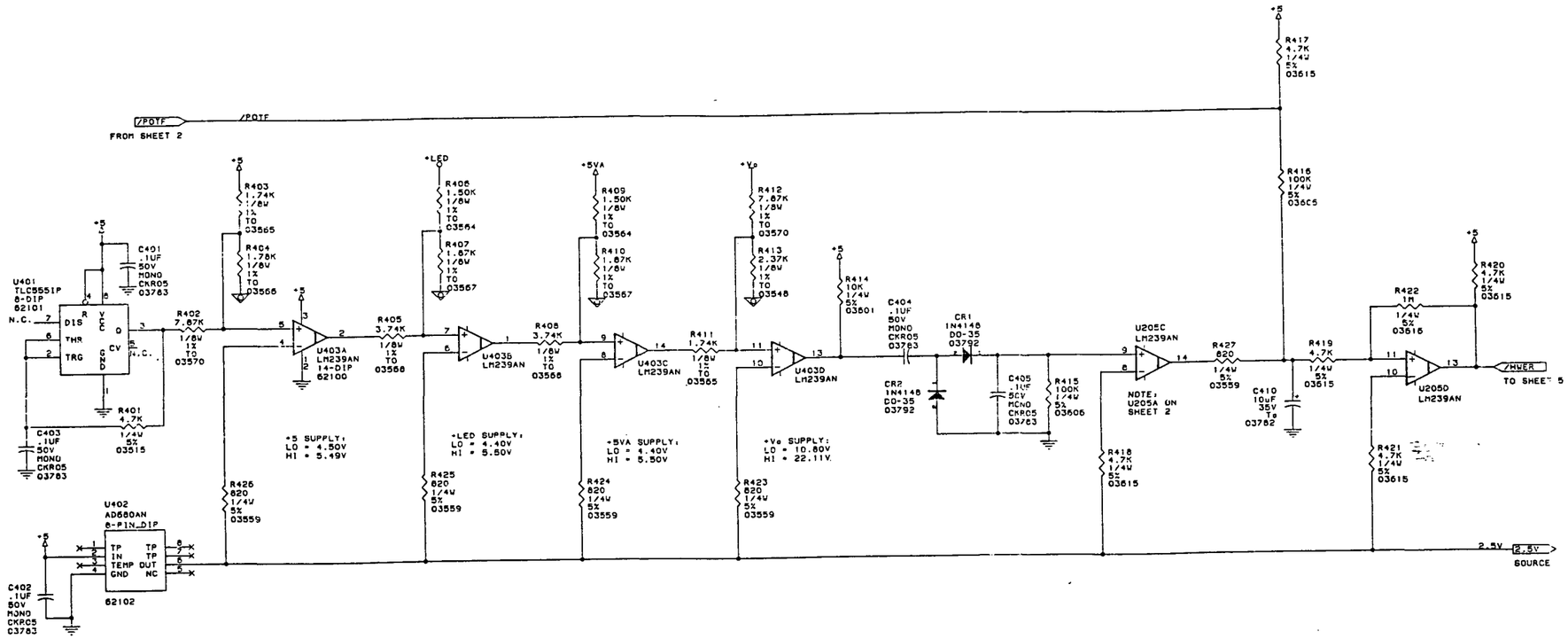
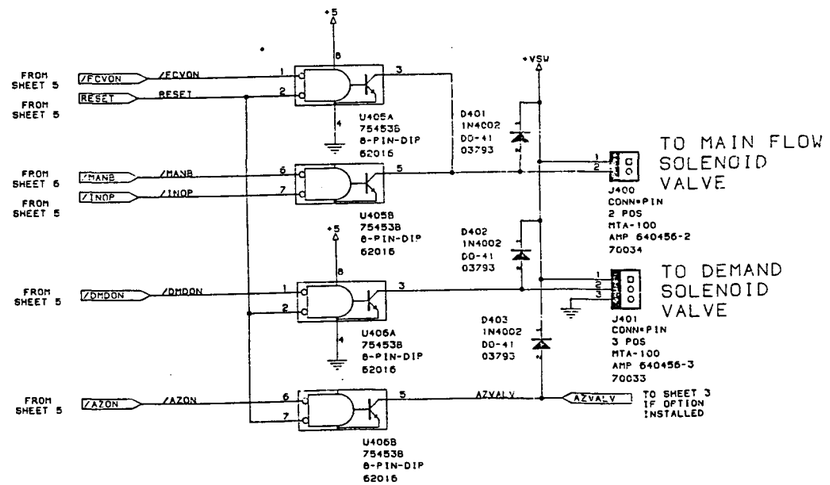
Figure 9.3.4 MAIN PRINTED CIRCUIT BOARD SCHEMATIC, SHEET 4 OF 6





D	DWG NO. 50372	REV. B
SCALE NONE	DO NOT SCALE DRAWING	SHEET 4 OF 6

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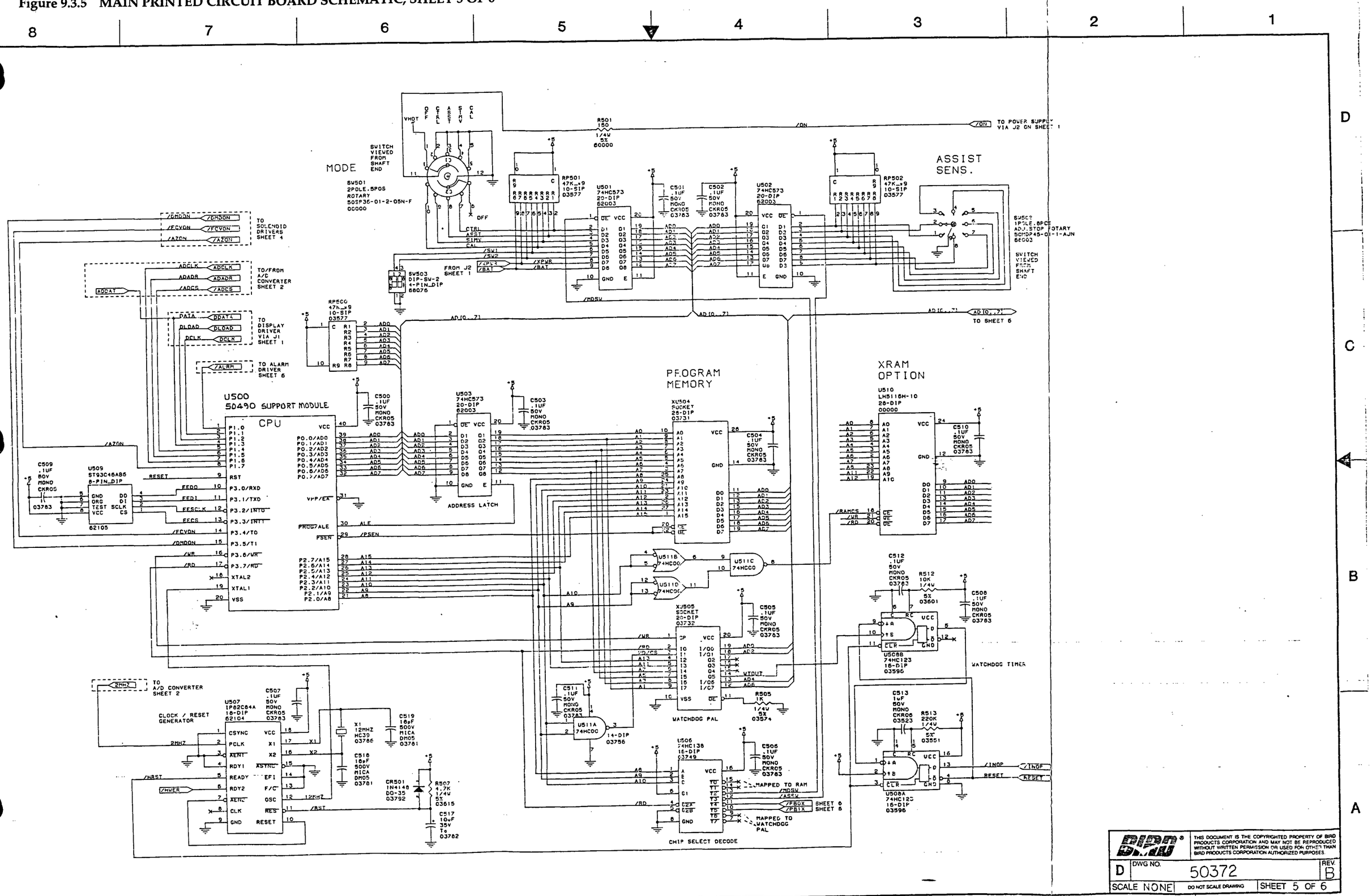
Figure 9.3.5 MAIN PRINTED CIRCUIT BOARD SCHEMATIC, SHEET 5 OF 6



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D	DWG NO. 50372	REV. B	
SCALE NONE	DO NOT SCALE DRAWING	SHEET 5 OF 6	

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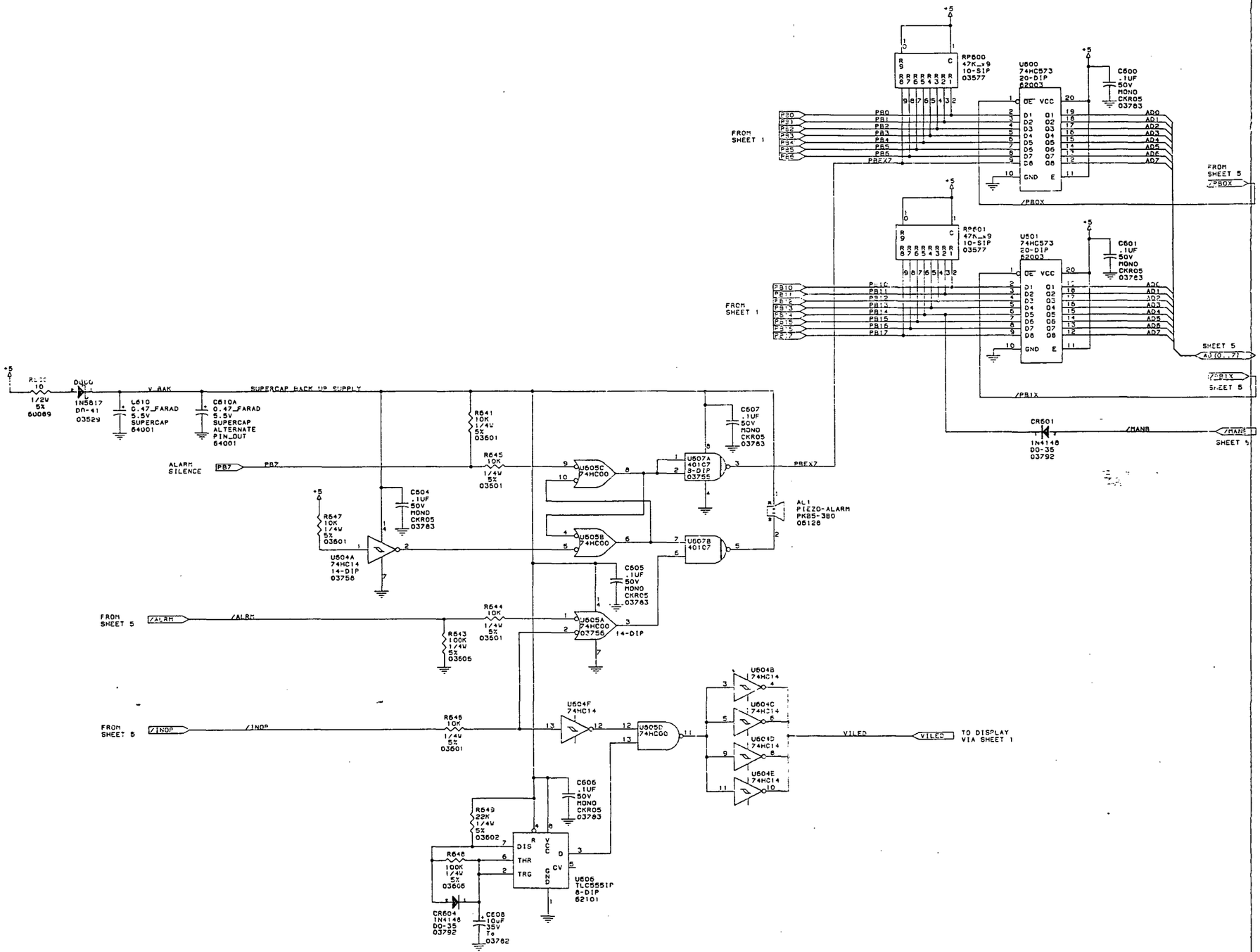
Figure 9.3.6 MAIN PRINTED CIRCUIT BOARD SCHEMATIC, SHEET 6 OF 6



D	DWG NO. 50372	REV. B
SCALE NONE	DO NOT SCALE DRAWING	SHEET 6 OF 6

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Figure 9.4: Display Printed Circuit Board Illustration (P/N 50380)

Figure 9.4 DISPLAY PRINTED CIRCUIT BOARD ILLUSTRATION (P/N 50380)

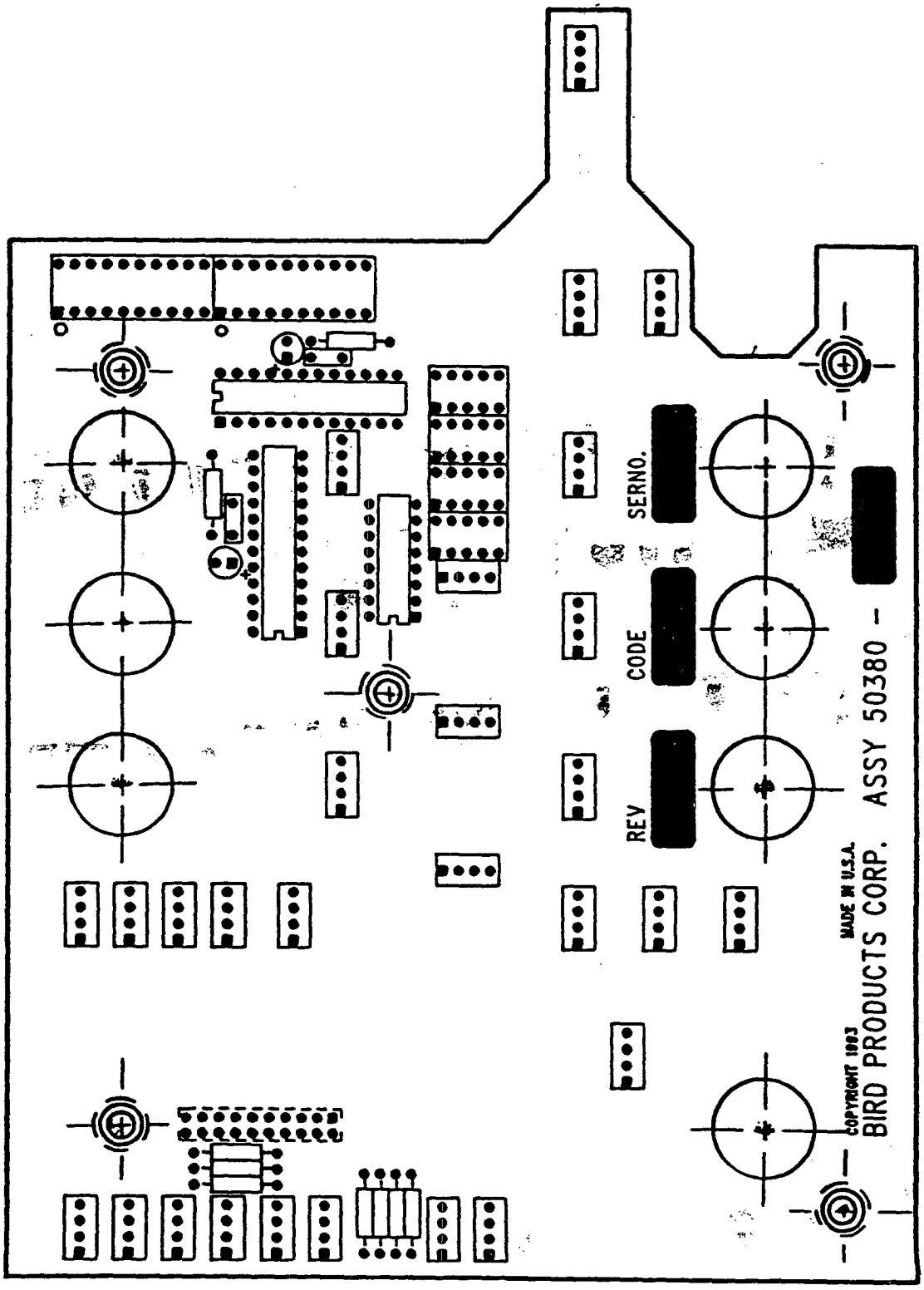

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Figure 9.4.1 DISPLAY PRINTED CIRCUIT BOARD SCHEMATIC

REVISIONS				
SYM	DESCRIPTION	DRFTG	APPROVED	DATE
X2	PROTOTYPE RELEASE	JKD	DD	11.17.92
X1	PILOT REL PER ECO# 50893	JKD		
A	PROD REL PER ECO # 51183	JKD	DD	3/30/93

NOTE: UNLESS OTHERWISE SPECIFIED.

1. REVISION STATUS CHANGES TO THIS DRAWING MUST BE REFLECTED ON DRAWING 50380E.

ITEM NO	QTY REQD	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION

MATERIAL LIST

UNLESS OTHERWISE SPECIFIED
1. TOLERANCES
.X ±.1 XXX ±.005
XX ±.01 ANG ±1°00'
2. MACH SURFACES √ OR BETTER
3. CORNER FILLETS & RADII .005-.010
4. BREAK ALL SHARP EDGES BY 45°
5. CHAMFER FIRST & LAST THREADS 45°
6. CONC TOLERANCE .005 F.I.M.
7. INTERPRET PER ANSI Y14
8. DIMENSIONS ARE IN INCHES

APPROVALS	DATE
DRAWN	11.16.92
CHECKED L.BAKER	11.17.92
APPROVED D.DeVRIES	11.17.92
RELEASED	
MAT'L	
FINISH	

TITLE
SCHEMATIC, 1000PV DISPLAY

D | DWG NO. 50382 | REV. A

SCALE NONE | DO NOT SCALE DRAWING | SHEET 1 OF 1

CRITICAL	COMPONENT	DEVICE	N/A
TRACEABLE	SERIAL NO	LOT NO	N/A

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Figure 9.5: Power Supply Printed Circuit Board Illustration (P/N 50390)

Figure 9.5 POWER SUPPLY PRINTED CIRCUIT BOARD ILLUSTRATION (P/N 50390)

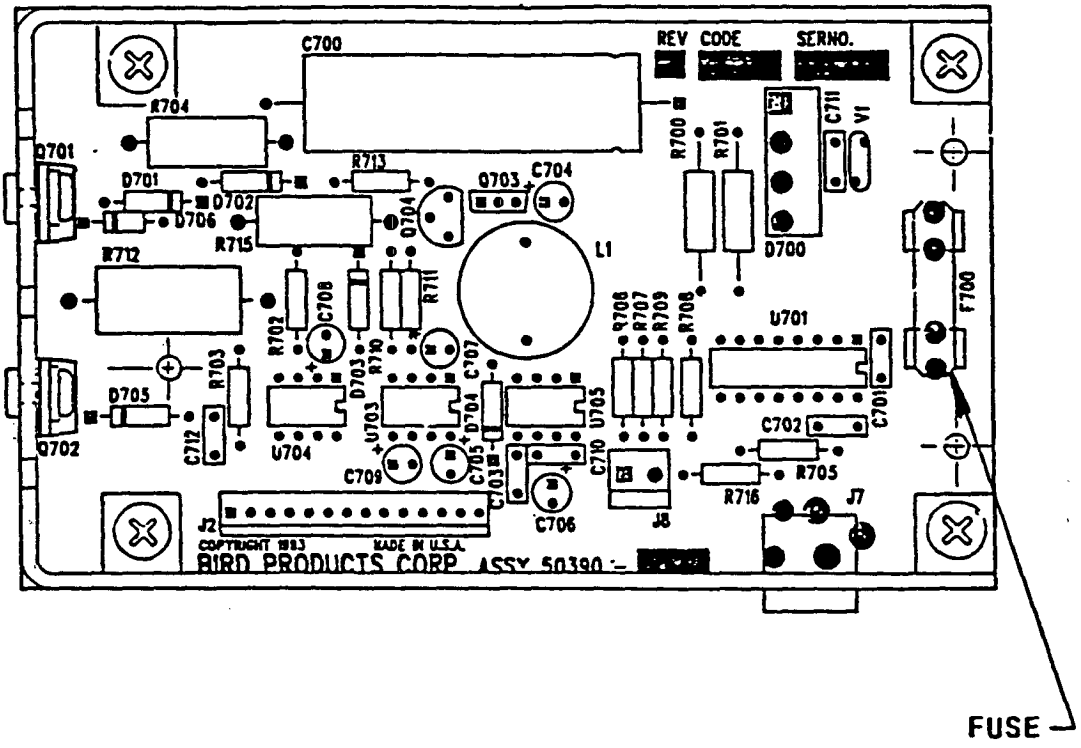

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Figure 9.5.1 POWER SUPPLY PRINTED CIRCUIT BOARD SCHEMATIC

REVISIONS				
SYM	DESCRIPTION	DRFTG	APPROVED	DATE
XX1	PROTOTYPE RELEASE			
XX2	PROTOTYPE RELEASE			
X1	PILOT RELEASE PER ECO# 50900		D D	3/30/93
A	PROD REL PER ECO# 51170		DD	3/30/93

VHOT IS ALWAYS LIVE.
0.3V BELOW BATTERY VOLTAGE WHEN NO EXTERNAL POWER
APPROXIMATELY 8.2V WHEN EXTERNAL POWER IS AVAILABLE

+Vo SWITCHED BY /ON SIGNAL
UPCONVERTED TO +12V +/-5%. 15mA MAX.

+VSW IS VHOT SWITCHED BY /ON SIGNAL

+LED IS SWITCHED BY /ON SIGNAL
REGULATED +5V +/-5% 200mA MAX.

+5 IS SWITCHED BY /ON SIGNAL
REGULATED +5V +/-5% 200mA MAX.

32V DC MAX
550mA DC MAX
11VDC MIN

J7 DCJACK 70150

F700 1A SLO BLO 5x20mm IEC 127 III IN 03795 CLIPS 09510

ENCLOSURE SHIELD

C714 1uF 50V MONO CKR06 03523

C711 1uF 50V MONO CKR06 03523

V1 V33ZA1 VARISTOR 68053

D700 RS402L 03797

C713 1uF 50V MONO CKR06 03523

L2 INDUCTOR COMMON MODE 000000

C712 1uF 50V MONO CKR05 03523

R715 100K 1/4W 5% 03606

VIN 550mA MAX AT -20C: 9.3V MIN INPUT

R700 0.5 OHM 1/2W 1% 60161

R701 0.5 OHM 1/2W 1% 60161

C700 3,300uF 35V ELECT 64043

R702 768K 1/8W 1% T2 60162

R703 124K 1/8W 1% T2 60163

C701 .1UF 50V MONO CKR05 03783

0702; HEATSINK AND 20207 THERMAL INTERFACE REQUIRED

Q702 TIP31B TO-220 60873

R712 470 2W 5% 60171

D705 1N4739A DO-41 66012 9.1V

0701; HEATSINK AND 20207 THERMAL INTERFACE REQUIRED

Q701 TIP32B TO-220 66074

U701 UC2906N 15-PIN_DIP 62106

CS OUT SINK
CSENSE- SOURCE
CSENSE+ COMP
CURLIM VSENSE
+VIN CH ENAB
GND TR BIAS
PWR IND STATE
OC TERM UC IND

C702 .1UF 50V MONO CKR05 03783

R705 470 1/4W 5% 03576

R704 910 1W 5% 60164

R706 52.3K 1/8W 0.5% T2 60165

R707 33.2K 1/8W 0.5% T2 60166

R709 392K 1/8W 0.5% T2 60168

R708 43.2K 1/8W 0.5% T2 60167

R713 4.7K 1/4W 5% 03615

/LINE ON

D705 1N4148 DO-35 03792

D701 1N5817 DO-41 03529

D702 1N5817 DO-41 03529

D703 1N5817 DO-41 03529

J3 CONN-PIN 2 POS MTA-156 70155

LCR6V4P BATTERY COMP -11.7mV/C

AT 45C:
VC = 6.828V
VF = 6.326V

AT 25C:
VC = 7.354V
VF = 6.852V

AT -20C:
VC = 7.881V
VF = 7.379V

Q703 MTD4P05-1 IRFU9010 IRFU9120 IRFU9020 TO-251 66077

U705 MAX532AEPA 8-PIN_DIP 62105

LBI COMP
LBO VFB
GND CP
LX VOUT

C704 100uF 16V To 64017

L1 237uH 71545

D704 1N5817 DO-41 03529

C710 1200pF 100V MONO CKR05 64004

C703 .1UF 50V MONO CKR05 03783

C706 100uF 16V To 64017

VHOT

/BAT REPORT LO BAT BELOW 5.32V INTO REGULATORS

U703 MAX667EPA 8-PIN_DIP 62107

SHDN GND
SET LBI
LBO OUT
IN DD

C709 22uF 16V To 64023

C707 100uF 6.3V To 64020

R710 4.07M 1/8W 1% T1 60169

R711 1.24M 1/8W 0.5% T2 60170

J2 CONN-PIN 14 POS MTA-100 AMP 1-640456-4 70148

/BAT
/XPWR
/ON
XPWR
GND
+LED
+5
-VSW
+Vo

U704 MAX667EPA 8-PIN_DIP 62107

SHDN GND
SET LBI
LBO OUT
IN DD

C708 100uF 6.3V To 64020

/XPWR REPORT LO LINE BELOW 9.03V OUT OF BRIDGE RECTIFIER

C715 910 1W 5% 60164

Q704 2N5551 TO-92 66040

TO RIGHT HALF OF BATT LO/FAIL ALARM LED

BCFAIL

NOTE: UNLESS OTHERWISE SPECIFIED

1. REVISION STATUS CHANGES TO THIS DRAWING MUST BE REFLECTED ON DRAWING 50390E.

ITEM NO	QTY REQD	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION

MATERIAL LIST

UNLESS OTHERWISE SPECIFIED
1. TOLERANCES
.X ±.1 .XXX ±.005
.XX ±.01 ANG ±1°00'
2. MACH SURFACES 63 OR BETTER
3. CORNER FILLETS & RADII .005/.010
4. BREAK ALL SHARP EDGES BY 45°
5. CHAMFER FIRST & LAST THREADS 45°
6. CONC TOLERANCE .005 F.I.M.
7. INTERPRET PER ANSI Y14
8. DIMENSIONS ARE IN INCHES

APPROVALS		DATE
DRAWN	L. BAKER	11.19.92
CHECKED	J.K. DRAL	11.20.92
APPROVED	D. DeVRIES	11.20.92
RELEASED		
MAT'L		
FINISH		

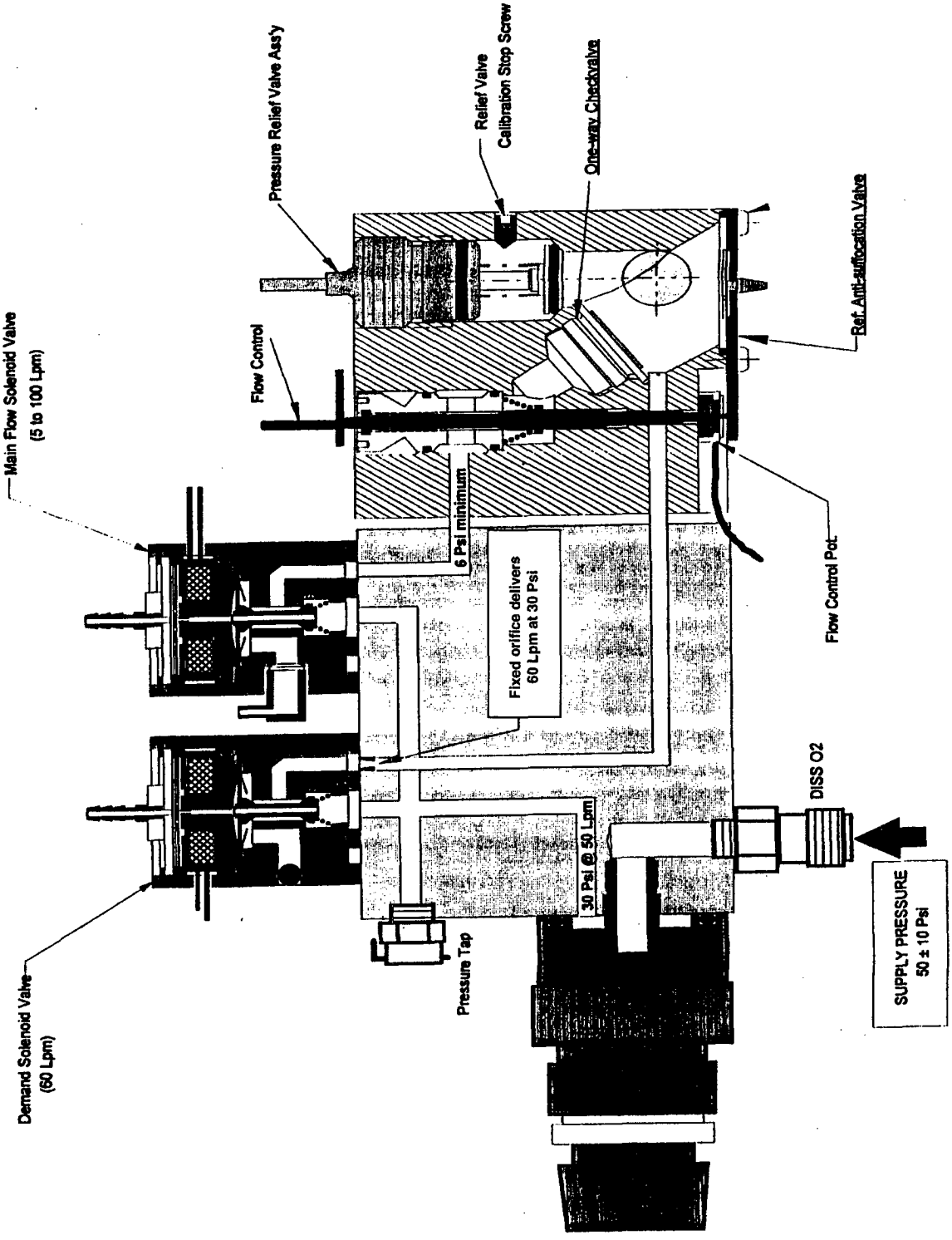
TITLE
SCHEMATIC, 1000PV POWER

D | DWG NO. 50392 | REV. A

SCALE NONE | DO NOT SCALE DRAWING | SHEET 1 OF 1

CRITICAL	COMPONENT	DEVICE	N/A
TRACEABLE	SERIAL NO.	LOT NO.	N/A

Figure 9.6 MANIFOLD ASSEMBLY (SECTIONAL VIEW)



GLOSSARY OF ABBREVIATIONS

amp ..... Ampere

BPM ..... Breaths Per Minute

C ..... Compliance

°C ..... Degrees Centigrade

CAL ..... Calibrated

CCW ..... Counterclockwise

CW ..... Clockwise

CIRC ..... Circuit

cm ..... Centimeter

cmH_2O ..... Centimeter of Water Pressure

cmH_2O/LPS ..... Centimeter of Water Pressure Per Liter Per Second

CMV ..... Controlled Mechanical Ventilation

CPAP ..... Continuous Positive Airway Pressure

CTRL ..... Central

D/A ..... Digital to Analog

DISS ..... Diameter Index Safety System

DVM ..... Digital Volt Meter

ETO ..... Ethylene Oxide

°F ..... Degrees Fahrenheit

FIO_2 ..... Fractional Concentration of Inspired Oxygen

H ..... Height

Hz ..... Hertz

I.D ..... Internal Diameter

I:E ..... Inspiratory Time to Expiratory Time Ratio

(I) ..... ON

IMV ..... Intermittent Mandatory Ventilation

kg ..... Kilogram

kg/cm2 ..... Kilograms Per Square Centimeter

GLOSSARY OF ABBREVIATIONS

L	Liter
lb	Pound
LED	Light Emitting Diode
LPM	Liters Per Minute
mA	Milliamp
MAP	Mean Airway Pressure
ml	Milliliter
mm	millimeter
msec	Millisecond
mV	Millivolt
(O)	OFF
O.D	Outside Diameter
O_2.	Oxygen
Paw	Airway Pressure
PEEP	Positive End Expiratory Pressure
PIP	Peak Inspiratory Pressure
P/N	Part Number
PSI	Pounds Per Square Inch
PSIG	Pounds Per Square Inch Gauge
SIMV	Synchronized Intermittent Mandatory Ventilation
t	Time
TCPL	Time Cycled, Pressure Limited
VAC	Volts Alternating Current
VDC	Volts Direct Current
Vt	Tidal Volume
W	Weight

ADDENDA